Permit Report

Permit Application No.: **14-577**

Rule: **Erosion Control, Floodplain Alteration, & Waterbody Crossings & Structures**

Applicant: **Metropolitan Council Environmental Services**
Project: **1-MN-344 Tunnel Improvements**
Location: **3901 Minnehaha Pkwy. E., Minneapolis**

Received: **11/21/2014**
Complete: **1/12/2015**
Noticed: **1/15/2015**

Recommendation:

Approval with conditions:

Conditions for permit issuance:

- Submittal of an agreement between MCES and the National Park Service providing for the NPS to perform daily spring-flow monitoring using the current bucket and stopwatch methodology.
- Submittal of the NPDES permit number for the project;
- Execution of an agreement between MCES and MCWD to reimburse MCWD for the direct costs and direct expenses of an on-site observer during construction of the two new access shafts and during the construction of the buried vault. The purpose of the MCWD on-site observer will be to document groundwater and geologic conditions encountered, particularly in the Platteville Limestone, and observe activities proposed by MCES to dewater the construction area and reduce or eliminate groundwater inflow into the new structures after construction. The observer will attend weekly construction meetings with MCES and the Contractor, when needed, and monitor temporary dewatering and spring flow measurements and prepare weekly reports documenting any deviations from the plans and specifications. The timeframe expected for construction is approximately two years. To avoid undue public expense, the terms of the agreement may identify more closely the times when the MCWD observer must be on site.
- Execution of an agreement between MCES and MCWD establishing a framework for evaluating and addressing any potential impact on flow to CCWS. The agreement will address communication of monitoring results; triggers for technical consultation; and an effective, timely process to determine what needs to be done and provide for the MCES to perform the necessary action. The agreement will provide as appropriate for third-party technical involvement.

Conditions applicable to the performance of the work:

- MCES will submit weekly electronic reports of daily discharge from Camp Coldwater Spring and the area-seep south of the Spring to MCWD in the form of an Excel spreadsheet.
- MCES will monitor and report daily dewatering amounts and locations with weekly submission of an electronic report or spreadsheet to MCWD
- MCES will construct the proposed tunnel improvements and interceptor line in accordance with the plans and specifications submitted, approved by the MCWD and incorporated herein, and with all construction means and methods stated therein, to the extent relevant to compliance with the District rules identified above and to the extent they may affect the flow of groundwater to CCWS or the risk of an impact thereto.
- MCES will take appropriate action in the event of an affect on groundwater flow to ensure that the project is brought into compliance with special legislation.
- MCES will submit as-builts to the MCWD upon completion of the project.
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Background:

Metropolitan Council Environmental Services (MCES) has applied for a Minnehaha Creek Watershed District permit for Erosion Control, Floodplain Alteration, and Waterbody Crossings & Structures for the installation of a new sanitary interceptor line located within MCES easements near 3901 Minnehaha Parkway E. in the City of Minneapolis (Fig. 3, Attachment 2). The project proposed will install a new, 5' diameter interceptor tunnel parallel to Minnehaha Parkway E., along with a large buried regulator vault and two vertical, 10 footdiameter access shafts. Existing facilities being replaced will be abandoned and grouted.

The new MCES sanitary interceptor has been proposed to address the aging infrastructure currently in place. The existing sanitary line and tunnel were constructed and installed in the early 1930s and have reached the end of their functional lifespan. The current system is corroding, difficult to inspect, and difficult to rehabilitate. Additionally, the current system is not equipped with a manual overflow system. Consequently, when the existing interceptor reaches a given capacity, combined overflow containing sanitary waste is discharged into the City of Minneapolis' Storm Sewer System and eventually the Mississippi River.

The tunnel improvement project is required to be implemented to address anticipated future EPA regulatory permit requirements for the management of wastewater and stormwater flows. The new regulator will be equipped with flow control gates that will be designed to control flow to the downstream interceptor system. The operation of the gates will be monitored by MCES both locally and remotely. The new tunnel will be approximately 1,000 feet in length, transporting flow from the new regulator under Minnehaha Creek, lightrail tracks, Highway 55, and other local roads before connecting back with the existing interceptor.

The applicant analyzed several alternatives to the proposed project, including:

- Rehabilitation of the existing structure;
- Retrofitting the existing structure with gates;
- Removal of existing metering facilities and replacement with new pipe and connection to the existing drop shaft;
- Rehabilitation of the 3'x 6' tunnel;

Rehabilitation of the existing structure was determined to be an infeasible alternative as this would require extensive above ground wastewater bypass diversion facilities that would need to transport significant flows around the project area.

Retrofitting the existing structure and removing the existing metering facilities were also determined to be infeasible alternatives. Because of the configuration, angle, and slope of the existing tunnel, a significant amount of disruption would be required in order to properly complete the work, in excess of what is proposed by the current project.

Rehabilitation of the existing 3' x 6' tunnel was also determined to be an infeasible alternative. Maintenance to tunnels is typically accomplished through use of CIPP lining, a cured in place foam product that expands and protects the tunnel and the pipe. Because of the state of the existing tunnel, its configuration, and the need to bypass wastewater flows, MCES determined rehabilitation of the tunnel to be infeasible and staff, with advice from the District engineer, concurs in that determination.

The proposed project construction will require a timeframe of 1.5 to 2 years and it is in proximity to Minnehaha Creek and Minnehaha Falls (Fig. 3, Attachment 2). The erosion control measures and Erosion Control plans submitted by the applicant meet the requirements of District rules. The project meets the requirements of the Floodplain Alteration rule and preserves floodplain storage capacities. The applicant meets the requirements of the Waterbody Crossings & Structures rule.

In addition to having regulatory authority for Erosion Control, Floodplain Alteration, and Waterbody Corssings & Structures in the City of Minneapolis, the District is bound to state legislation, 2001 Ch. 101, which states:

> "Neither the state, nor a unit of metropolitan government, nor a political subdivision of the state may take any action that may diminish the flow of water to or from Camp Coldwater Springs. All projects must be reviewed under the Minnesota Historic Sites Act and the Minnesota Field Archaeology Act with regard to the flow of water to or from Camp Coldwater Springs."

Accordingly, the District has carefully examined the MCES proposal, including the work of its hydrogeological consultant, to assess the potential for alteration of groundwater flows that would result in a reduction of flow to CCWS. It is planned that the project will involve temporary dewatering of the excavation area of the buried vault (located in the Platteville limestone bedrock); in addition, three large diameter wells will be installed in the underlying St. Peter sandstone to temporarily dewater the area where the new tunnel will be advanced. Although not planned, some dewatering may be required during advancement of the large diameter access shafts. The quantity/rate of temporary dewatering as well as flow from CCWS will be monitored and reported on a weekly basis. According to a groundwater model developed by MCES, a temporary reduction of spring flow could result.

However, the District engineer concurs in an assessment performed by the MCES consultant that due to factors including the distance of the work from CCWS and the size of the groundwatershed to CCWS, the effect of this reduction most likely would not be measurable at the spring. Flow is expected to return to ambient conditions after dewatering ceases.

Monitoring the Camp Coldwater Spring Flow:
Continual weekly monitoring of the spring flow has been in place since late 1998, and has continued through the present. However, it is important to note that some changes have occurred as follows:

First, the National Park Service undertook activities in its role as custodian of the property around the spring. Buildings, road embankments and a culvert were removed in the vicinity. Grading of the site along with vegetation management has also occurred. As a result, the historic location of monitoring flow has been moved to the spring house.

Also, under an agreement with MCWD, the National Park Service has taken over responsibility for monitoring the flow, introducing new personnel and potential variances in the data. As a result of these changes. Direct comparison of the NPS data with monitoring data previously collected by MCWD and other entities is subject to consideration of these transitional changes.

Proposed conditions under this permit include a thorough flow monitoring regime. Under this regime monitoring would follow protocols that the NPS has been using, and therefore will have a base of reference in the NPS monitoring data to date and in the trends produced over the course of the proposed work.

Erosion Control:
The Erosion Control Rule is triggered for any project involving 5,000 square feet of soil disturbance or 50 cubic yards of excavation or stockpiling of soil. The proposed project involves approximately 1.85 acres of disturbance within the City of Minneapolis therefore triggering the Erosion Control Rule. The erosion control practices proposed meet District standards. Construction BMP's provided include rock construction entrances, silt-fence, heavy-duty silt-fence, inlet protection, sod, seeding, street sweeping, vegetation and tree protection, turf reinforcement, filter boxes, jersey barriers, and erosion control blankets. All disturbed areas will be stabilized with 6" top soil and seeded/sodded upon project completion. All erosion control requirements have been met.

Floodplain Alteration:
The Floodplain Alteration rule is triggered for any project involving the alteration or filling of land below the projected 100-year high water elevation of a waterbody. The proposed project involves the excavation of land located below the 100-year high water elevation of Minnehaha Creek in the form of surface disturbance associated with advancing the vertical shafts and vault. Because no fill is proposed, and no loss of flood storage will occur, no compensatory flood storage is required, nor will the excavation cause an increase in the 100-year flood elevation. Criteria 3(d), (e), and (f) do not apply. The applicant has met all the criteria of the rule.

Waterbody Crossings & Structures:
The Waterbody Crossings & Structures rule is triggered for any project involving the placement of a road, highway, utility or associated structure in contact with the bed or bank of any waterbody, including alteration of a waterbody to enclose it within a pipe or culvert and placement of fill below the Ordinary High Water (OHW) line. The proposed project involves the directional boring and installation of a new sanitary sewer line underneath Minnehaha Creek. The crossing in this case will be about 40 feet beneath the bed of the creek, however the rule does not explicitly state a depth at which the rule no longer applies. Therefore, staff has reviewed the proposed work against the criteria of the Waterbody Crossings & Structures rule and finds that the criteria are met.

A purpose of the proposed project is to replace aging sanitary sewer infrastructure that is currently in place near 3901 Minnehaha Pkwy E., Minneapolis. The sanitary line has been designed to provide service to the public and reduce the environmental impact that is currently imposed by the existing line. Because no manual overflow structure exists, the interceptor line currently discharges all overflow to the Mississippi River through the City of Minneapolis' Storm Sewer System once a given capacity has been reached. The applicant has submitted the required and applicable alternatives analysis and has demonstrated the minimal impact solution.

The applicant analyzed several alternatives to the proposed project, including:

- Rehabilitation of the existing structure;

- Retrofitting the existing structure with gates;
- Removal of existing metering facilities and replacement with new pipe and connection to the existing drop shaft;
- Rehabilitation of the 3’x 6’ tunnel;

Rehabilitation of the existing structure was determined to be an infeasible alternative as this would require extensive above ground wastewater bypass diversion facilities that would need to transport significant flows around the project area.

Retrofitting the existing structure or removing the existing metering facilities were also determined to be infeasible alternatives. Because of the configuration, angle, and slope of the existing tunnel, a significant amount of disruption would be required in order to properly complete the work.

Rehabilitation of the existing 3’ x 6’ tunnel was also determined to be an infeasible alternative. Maintenance to tunnels is typically accomplished through use of CIPP lining, a cured in place foam product that expands and protects the tunnel and the pipe. Because of the unknown state of the existing tunnel, its configuration, and the need to bypass wastewater flows, rehabilitation of the tunnel was determined to be an infeasible alternative.

Because each of these alternatives is infeasible, the applicant has demonstrated the least impact solution.

Due to the depth at which the new interceptor line will be installed, there will be no adverse effects to water quality. The project provides greater than three feet clearance below the bed of the waterbody, and a setback of 100 feet from stream banks for bore pits. Criteria (b), (c), and (d) do not apply to this project.

Minnesota State Legislation, 2001 Ch. 101:
As stated in Minnesota State Legislation, 2001 Ch. 101:

> “Neither the state, nor a unit of metropolitan government, nor a political subdivision of the state may take any action that may diminish the flow of water to or from Camp Coldwater Springs. All projects must be reviewed under the Minnesota Historic Sites Act and the Minnesota Field Archaeology Act with regard to the flow of water to or from Camp Coldwater Springs.”

The District engineer has reviewed potential impacts of the proposed work. The review is summarized in the January 14, 2015 memorandum from Chris Meehan and Mike Panzer, which in turn included review of an assessment performed by Kelton Barr of Braun Intertec on behalf of the applicant.

Installation of the-regulator vault will occur near the basal portion of the Platteville Limestone. The general consensus from prior assessment is that about two-thirds of the groundwater flow to CCWS derives from the basal Platteville limestone north and west of the spring. There is also a system of bedrock joints trending Northwest to Southeast and Northeast to Southwest. One of these joints or family of joints trends from Northwest (near the proposed vault) to Southeast intersecting the spring. An excavation in the basal Platteville limestone near the orientation of this joint near 50th Street and Hiawatha Avenue yielded a flow of approximately 500 gpm for several months during MnDOT construction of Hwy 55 about 15 years ago (Figure 7, Attachment 8). Dewatering at this location resulted in a measureable reduction of the spring flow approximately 1 mile to the southeast. The vault elevation coincides with the basal Platteville. If it is in a location that aligns with this joint, there is potenital need for substantial construction dewatering of the same nature may arise. Grouting of fractured rock around the vault would be one method used to address working conditions, but has potential to affect flow routes and would be minimized. The impact of this dewatering would be temporary. In an unlikely but conceivable scenario, hydrologic conditions at the vault location would require permanent localized depression of groundwater. In this case, the MCES would be required to use a method that did not result in any wider effect on groundwater flows so as to reduce flows to CCWS. Based on the current understanding of the underlying geology and support hydrology to CCWS, this scenario is unlikely, but considered to develop comprehensive mitigation plans.

The two 10 foot diameter access shafts will also penetrate the basal Platteville, which accounts for almost all horizontal transmissivity in the formation. Grouting would be used to seal these penetrations, which is a reliable, permanent method. Only minor grouting is expected to be needed. Finally, two to three dewatering wells will be used to facilitate construction of the new tunnel. The tunnel is located in the St. Peter sandstone beneath the

Platteville limestone. The St. Peter sandstone does not contribute water to the spring and so any diversion or removal of groundwater from this formation would not affect flow to CCWS.

Based on modeling performed by Kelton Barr and subsequent analysis by the District engineer, the risk of permanent and measurable impact to CCWS is very low based upon what is currently known about its support hydrology. However, the specific conditions at the locations of the vault and access shafts are not known and therefore potential impact scenarios cannot be ruled out. For this reason, District staff recommends observation and rigorous monitoring during construction, as well as agreement on a process to be followed in the event an impact is observed to determine the contingency measures that MCES will take and provide for their implementation.

The limits and extent of the grouting to control infiltration of groundwater from the Platteville limestone will be based upon the actual conditions and geology encountered during construction. District staff is recommending that an observer qualified in construction techniques and hydrogeology be present on-site during critical times to observe and consult on conditions and document the construction impacts on geology.

In addition to being subject to District permit requirements, as a political subdivision of the state, the applicant independently is subject to the special legislation and obligation directly under that law to avoid reducing flow to CCWS. The applicant has advised that resources are dedicated to planning for and responding to contingencies.

MCWD staff recommendations are listed above.

Attachments:

1. Permit application
2. Wenck Technical Memorandum – January 14th, 2015
3. Wenck Technical Memorandum – February 8th, 2005
4. MnDOT memo – Regarding flow to/from CCWS
5. MnDOT hydrogeology report
6. Braun Intertec hydrogeology report
7. Photo of joint flow from Highway 55 excavation
8. Project map

Tom Dietrich — Date: 1/29/2015

Print Form

14-577

WATER RESOURCE PERMIT APPLICATION FORM

Use this form to notify/apply to the Minnehaha Creek Watershed District (MCWD) of a proposed project or work which may fall within their jurisdiction. Fill out this form completely and submit with your site plan, maps, etc. to the MCWD at:
15320 Minnetonka Blvd. Minnetonka, MN 55345.
Keep a copy for your records.

YOU MUST OBTAIN ALL REQUIRED AUTHORIZATIONS BEFORE BEGINNING WORK.

1. Name of each ~~property~~ Easement owner: Metropolitan Council Environmental Services
Mailing Address: 390 Robert Street North City: St. Paul State: MN Zip: 55101
Email Address: Bryce.Pickart@metc.state.mn.us Phone: 651-602-1000 Fax: 651-602-1083

2. Property Owner Representative Information (not required) (licensed contractor, architect, engineer, etc…)
Business Name: Brown and Caldwell Representative Name: Doug Henrichsen
Business Address: 30 E. 7th Street, Suite 2500 City: St. Paul State: MN Zip: 55101
Email Address: dhenrichsen@brwncald.com Phone: 651-468-2077 Fax: 651-298-1931

3. Project Address: 3901 Minnehaha Parkway E. City: Minneapolis
State: MN Zip: 55417 Qtr Section(s): NE 1/4 Section(s): 18 Township(s): T28N Range(s): 23W
Lot: ____ Block: ____ Subdivision: ____ PID: 180282312005

4. Size of project parcel (square feet or acres): 2.05 Acres
Area of disturbance (square feet): 80,586 Volume of excavation/fill (cubic yards): 21,590
Area of existing impervious surface: 7,200 Area of proposed impervious surface: 7,800
Length of shoreline affected (feet): 460 Waterbody (& bay if applicable): Minnehaha Creek

5. Type of permit being applied for (Check all that apply):
- [x] EROSION CONTROL
- [ ] FLOODPLAIN ALTERATION
- [x] WETLAND PROTECTION
- [ ] DREDGING
- [ ] SHORELINE/STREAMBANK STABILIZATION
- [x] WATERBODY CROSSINGS/STRUCTURES
- [ ] STORMWATER MANAGEMENT
- [ ] APPROPRIATIONS
- [ ] ILLICIT DISCHARGE

6. Project purpose (Check all that apply):
- [ ] SINGLE FAMILY HOME
- [ ] ROAD CONSTRUCTION
- [x] UTILITIES
- [ ] DREDGING
- [ ] SHORELINE/STREAMBANK STABILIZATION
- [ ] MULTI FAMILY RESIDENTIAL (apartments)
- [ ] COMMERCIAL or INSTITUTIONAL
- [ ] SUBDIVISIONS (include number of lots)
- [ ] LANDSCAPING (pools, berms, etc.)
- [ ] OTHER (DESCRIBE):

7. NPDES/SDS General Stormwater Permit Number (if applicable): ____

8. Waterbody receiving runoff from site: Minnehaha Creek/Mississippi River

9. Project Timeline: Start Date: 03/01/2014 Completion Date: 12/31/2016

Permits have been applied for: City [x] County [x] MN Pollution Control Agency [x] DNR [ ] COE [ ]
Permits have been received: City [ ] County [ ] MN Pollution Control Agency [ ] DNR [ ] COE [ ]

By signing below, I hereby request a permit to authorize the activities described herein. I certify that I am familiar with MCWD Rules and that the proposed activity will be conducted in compliance with these Rules. I am familiar with the information contained in this application and, to the best of my knowledge and belief, all information is true, complete and accurate. I understand that proceeding with work before all required authorizations are obtained may be subject to federal, state and/or local administrative, civil and/or criminal penalties.

Bryce J. Pickart — 11/17/14

Signature of Each ~~Property~~ Easement Owner — Date

RECEIVED NOV 21 2014 By____

Application Checklist for Erosion Control Permit

To meet Rule B requirements, please complete the following checklist and submit the required materials. This checklist is intended primarily as a guide for smaller projects such as single family homes. Additional materials may be required. See the complete Erosion Control Rule text for more detail.

__N/A__ A $10.00 application fee payable to MCWD. **Checks only. MCWD cannot accept cash or credit cards.**

__X__ A completed Water Resource Permit Application Form And the New Erosion Control Supplemental Form with original signatures. Be sure to fill out and sign both pages.

__X__ A site plan (11"x17" in size or smaller) that shows the following (see example):

- ☐ Site property lines.
- ☐ Existing and proposed elevation contours sufficient to show drainage on and adjacent to the site.
- ☐ The site location in relation to surrounding roads, steep slopes, significant geographic features, buildings and other structures.
- ☐ Identification and location of all water features and facilities on-site and within 1000 feet of the area to be disturbed including any lake, stream or wetland; any natural or artificial water diversion or detention area; any surface or subsurface drainage facility or stormwater conveyance; and any storm sewer catch basin within 100 feet and down-gradient of the area to be disturbed.
- ☐ Existing 100 year flood elevation, if applicable.
- ☐ Location of proposed grading or other land-disturbing activity and location of stockpiles.
- ☐ Quantities of soil or earth material to be removed, stored or otherwise moved on site.
- ☐ Locations of proposed runoff control, erosion prevention, sediment control and temporary and permanent soil stabilization measures, including:
    - o Perimeter control along all roads and trails.
    - o Perimeter control at the bottom of all slopes leading off site or toward water resources.
    - o Perimeter control and/or cover around/on all large stockpiles.
    - o Crushed rock or existing paved construction entrance, only 1 allowed per site.

    NOTE:
    - ➢ All erosion and sediment control measures must be in place before any land disturbing activity begins.
    - ➢ Silt fence must be trenched in six inches and installed according to instructions

__X__ A permanent stabilization plan that states the following (can be written on site plan):

- ☐ Addition of at least 6" of topsoil to all disturbed areas.
- ☐ Method for establishing permanent vegetative cover.

__X__ A soils engineering report as described at paragraph 6 of Rule B, if requested by the District.

__X__ A geological report as described at paragraph 6 of Rule B, if requested by the District.

__N/A__ A surety is required for project disturbing greater than one acre.

Note: The permittee may be required to implement additional sediment/erosion control measures upon request from MCWD staff if, at any time after the permit is issued, it is considered necessary for compliance with Rule B policies.

Erosion Control Supplemental Information

Final Stabilization will be provided with (seed, sod, etc): Sod

and 6 inches of topsoil will be added/replaced prior to final stabilization.

Concrete Washout: Location of concrete washout

__ Off site X Indicated on site plans __ Other (description): __ No concrete washout:

Vegetation: Protective fencing will be installed as necessary so as to exclude all fill and equipment from the drip line or critical root zone, whichever is greater, of all vegetation to be retained.

X Yes __ Not Applicable __Other (description):

Inspections: An erosion control inspection plan is required for all projects disturbing ¼ acre or greater. The inspection requirements are as follows:

1) *The individual identified as being responsible for implementing the erosion control plan must routinely inspect the construction site once every seven days during active construction and within 24 hours after a rainfall event greater than 0.5 inches in 24 hours.*
2) *All inspections and maintenance conducted during construction must be recorded in writing and these records must be retained with the erosion control plan and made available at the District's request within 24 hours. Records of each inspection and maintenance activity shall include:*
   - i. *Date and time of inspections;*
   - ii. *Name of person conducting inspections;*
   - iii. *Findings of inspections, including recommendations for corrective actions;*
   - iv. *Corrective actions taken (including dates, times and party completing maintenance activities); and*
   - v. *Date and amount of all rainfall events greater than 0.5 inches in 24 hours.*

Provide the following information for the primary individual responsible for implementing the erosion control plan:

Name David Elzinga, Principal Contract Administrator

Organization Metropolitan Council Environmental Services

Phone 651-602-8924 Alternate Phone ____________

Email David.Elzinga@metc.state.mn.us

I certify that I am familiar with the requirements of the MCWD Erosion Control Rule and that the proposed activity will be conducted in compliance with this rule.

Bryce J. Pickart
Signature of Applicant or Authorized Agent

11/17/14
Date

Mike Panzer, Vice President
Wenck Associates, Inc.
1800 Pioneer Creek Ctr.
P.O. Box 249
Maple Plain, MN 55359-0249

(763) 479-4207
Fax (763) 479-4242
E-mail: mpanzer@wenck.com

TECHNICAL MEMORANDUM

TO: Thomas Dietrich, Minnehaha Creek Watershed District Permitting Technician

FROM: Chris Meehan, P.E., CFM, Wenck Associates, Inc.
Mike Panzer, P.E., P.G., Wenck Associates, Inc.

DATE: January 14, 2015

SUBJECT: Metropolitan Council Environmental Services 1-MN-344 Tunnel Improvements Review

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PROJECT SUMMARY

Metropolitan Council Environmental Services (MCES) is proposing to repair the existing regional sanitary inceptor line which crosses under Minnehaha Creek near 3901 Minnehaha Parkway E. in the City of Minneapolis. The project is a regional sewer interceptor improvement which proposes to construct:

- A new 5' diameter interceptor parallel to Minnehaha Parkway E.
- 44ft x 60ft regulator vault with odor controls
- Two 10' diameter access shafts

The project is near a known preferential path for groundwater flow to Camp Coldwater Spring (CCS) and due the District being bound to state legislation, 2001 Ch. 101, which states:

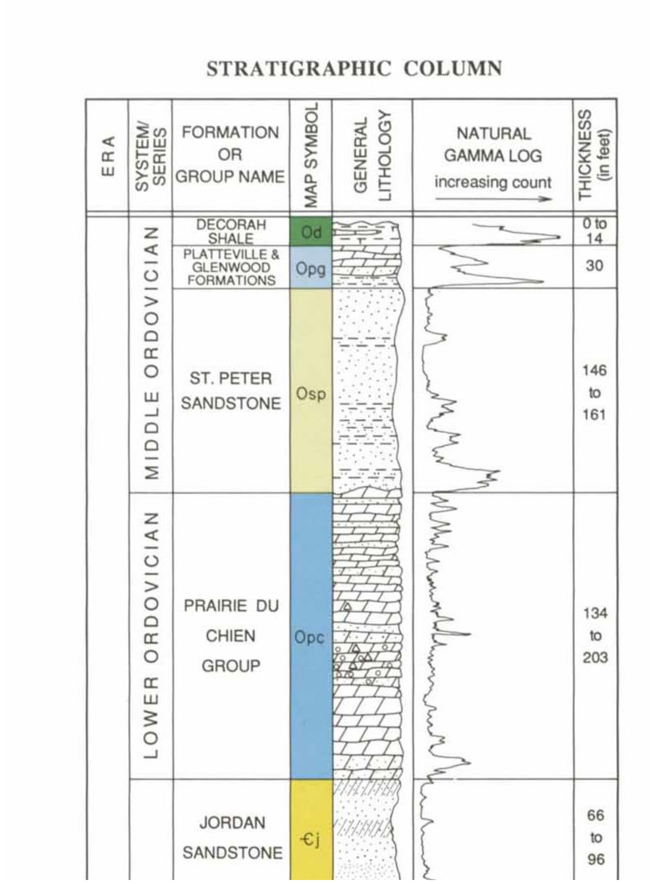
> "Neither the state, nor a unit of metropolitan government, nor a political subdivision of the state may take any action that may diminish the flow of water to or from Camp Coldwater Springs. All projects must be reviewed under the Minnesota Historic Sites Act and the Minnesota Field Archaeology Act with regard to the flow of water to or from Camp Coldwater Springs."

Accordingly, the District has intently examined the submissions of MCES to assess any risk imposed to CCS. This memo is meant to serve as a summary of our review.

<u>HYDROGEOLOGY - BACKGROUND INFORMATION</u>

Seeps appearing along the Mississippi River bluff are the manifestation of ground water moving predominantly horizontally toward the river and discharging at the bluff face. In the area near

Minnehaha Falls, the typical geology associated with the seeps is tens of feet of gravel, sands, silts and clay overlaying what is left of the Platteville Limestone (much of the upper portion of the Platteville and Decorah Shale has been eroded away by glacial activity). Underlying the Platteville is the Glenwood Shale and the St. Peter Sandstone which is tens of feet thick.

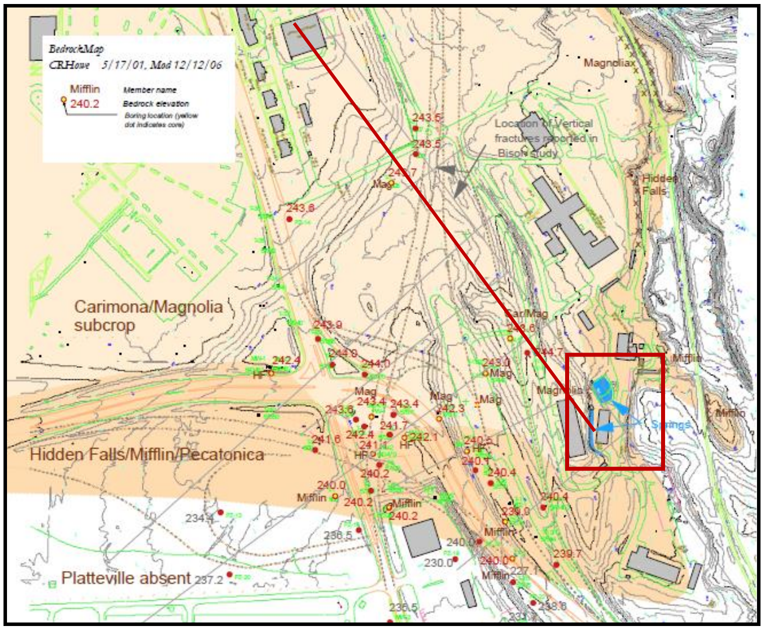


Source: Washington County Bedrock Geology, Minnesota Geological Survey

Many of the seeps (and Camp Coldwater Spring) are located vertically near the base of the Platteville as a result of a basal Magnolia sub-formation discontinuity. In this location there is a continuous horizontal basal discontinuity marking a temporary interruption of the depositional process, later exaggerated by solution processes, creating a horizontal preferential flow path for the movement of groundwater. Immediately below this discontinuity are feet of significant shale layers which impede downward movement of water and promote horizontal movement. Thus many of the seeps appear near this interface when it intersects the erosional surfaces of the rock bluffs. This is the case for Camp Coldwater Spring.

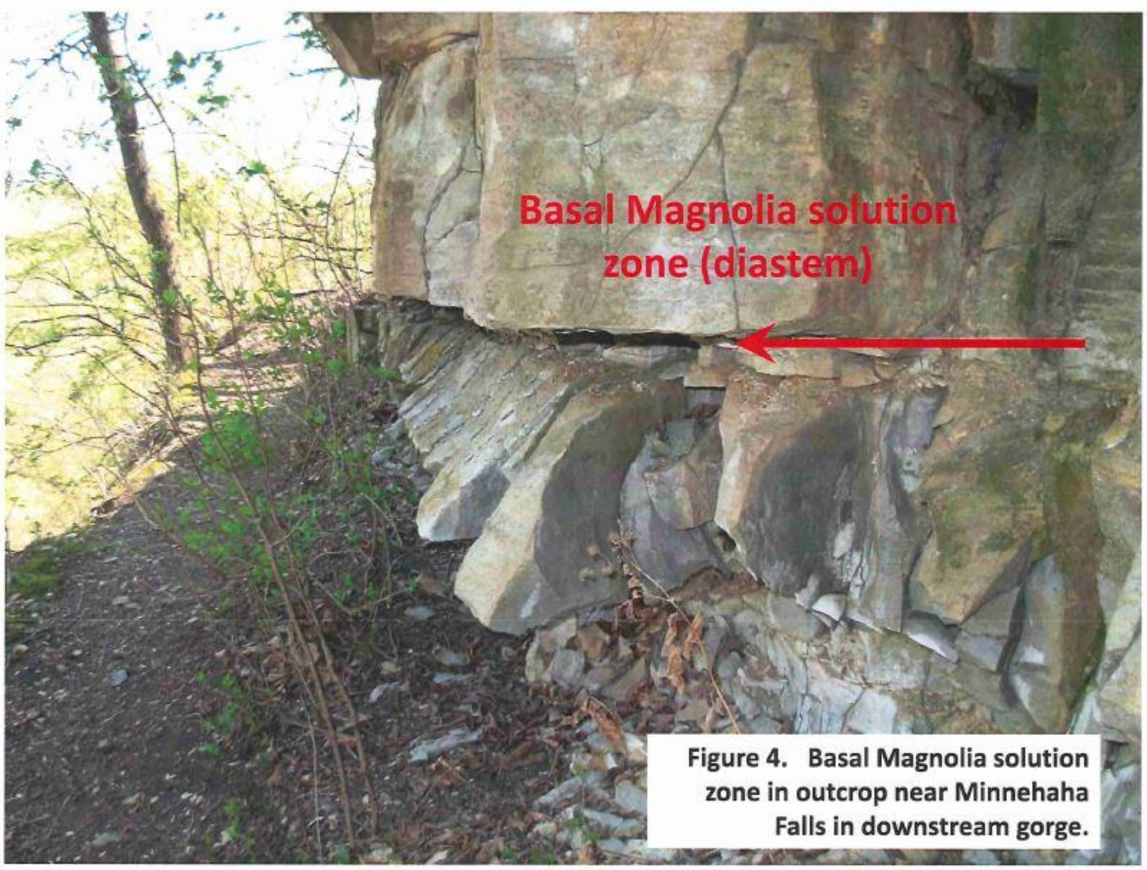
Camp Coldwater Spring has a special geologic setting that involves the above description coupled with the intersection of vertical joints in the bedrock. The most important ones for this discussion trend in a Northwest to Southeast direction (Figure 1). They can be viewed along the bluffs and the major ones extend vertically through the Platteville into the St. Peter Formations. One of these major joints passes through the spring area, adding another preferential flow path. The spring appears at the intersection of the horizontal discontinuity at the base of the Platteville Limestone, with the outcropping of the basal limestone at the river bluff, and with the location of a major Northwest to Southeast joint in the bedrock.

Figure 1 – Approximate Vertical Joint Locations Associated with Camp Coldwater Spring



C.R. Howe, modified 12/12/06, major fault and Camp Coldwater Spring highlighted for clarity

Figure 2 – Basal Magnolia Sub-Formation Discontinuity



Braun, 2014

Monitoring the Camp Coldwater Spring Flow:
Continual weekly monitoring of the spring flow has been in place since late 1998, and has continued through the present. However, it is important to note, that some changes have occurred. First, the National Park Service undertook activities to restore the property around the spring. Buildings, road embankments and a culvert were removed in the vicinity. Grading of the site along with vegetation management has also occurred. As a result, the historic location of monitoring flow has been moved to the spring house.

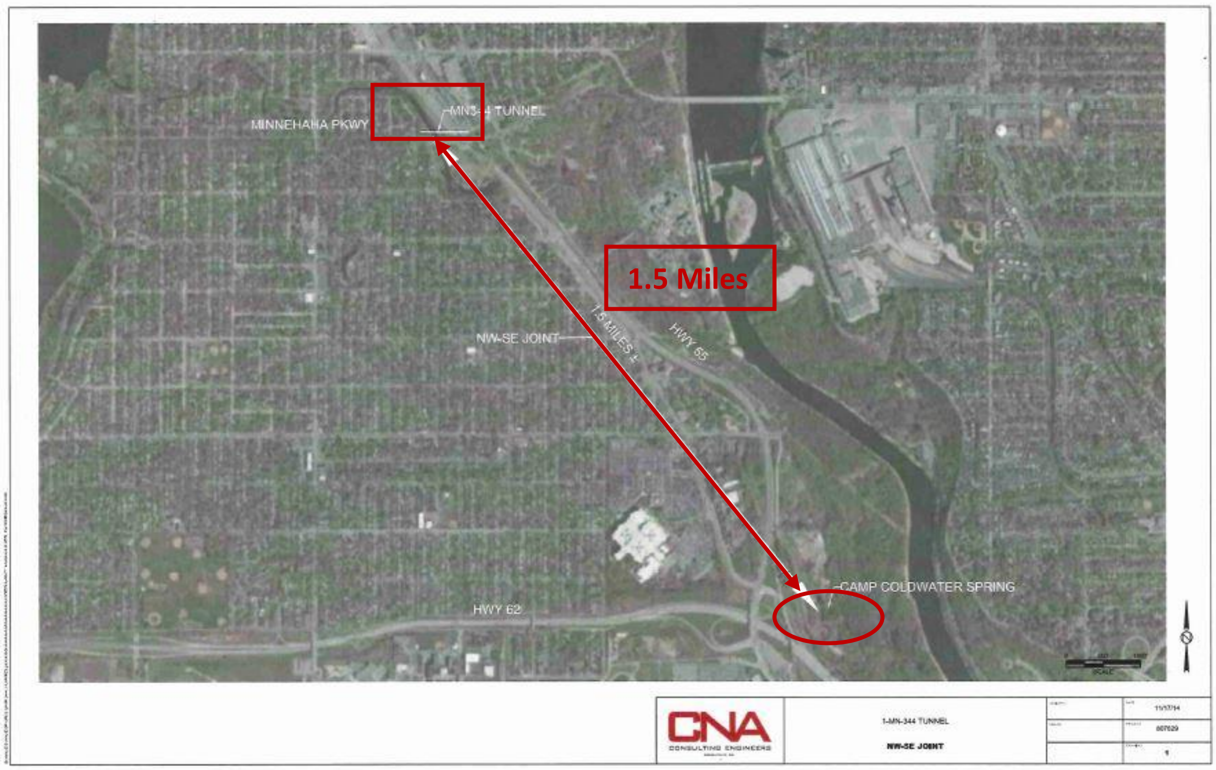
Also, under an agreement with MCWD, the National Park Service has taken over responsibility for monitoring the flow, introducing new personnel and potential variances in the data. As a result of these changes direct comparison of the NPS data with monitoring data previously collected by MCWD and other entities is not possible.

PROJECT SUMMARY

MCES is proposing to complete the 1-MN-344 Tunnel Improvements which are in the vicinity of the basal Magnolia sub-formation discontinuity of the Platteville and vertical joint attributed to flows in Camp Coldwater Spring (Figure 3-5). The construction of the improvements consists of numerous activities which include:

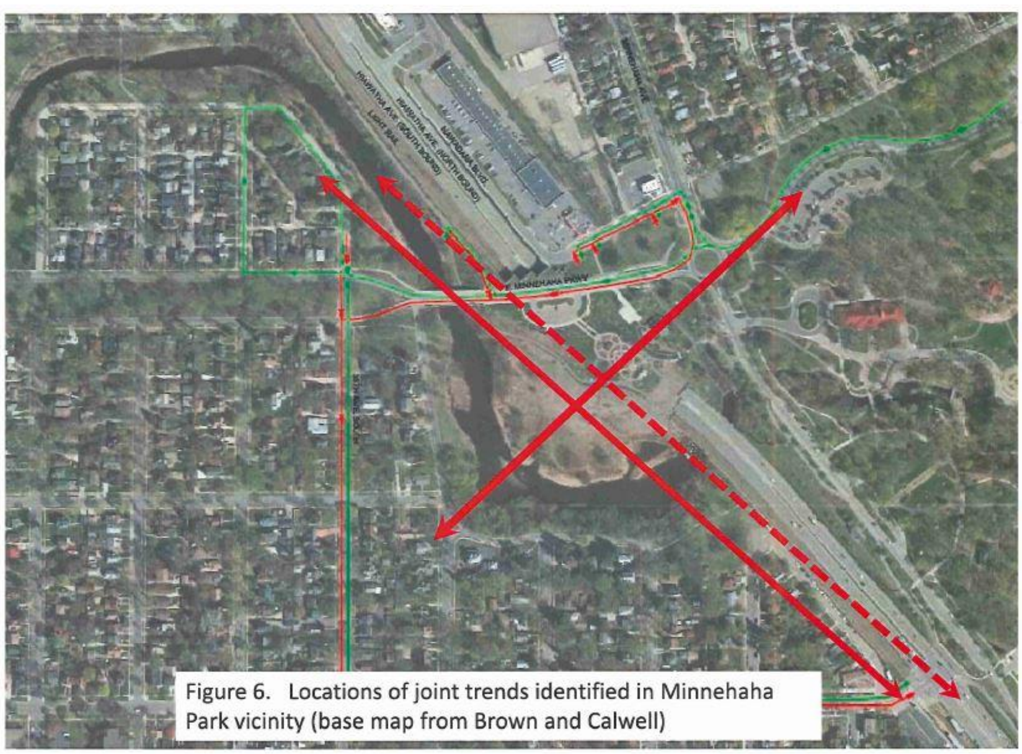
- Abandonment of an existing East-West tunnel in-place, built more than 75 years ago. This tunnel is located some 30-40 feet below the water level in the St. Peter Sandstone and carries sewage flows from west to east under Hwy 55. Not much is known about the condition of this tunnel and it will be filled with a neat grout with foam additives to make the fill lightweight.
- Construction of a new tunnel in roughly the same horizon and parallel to the existing tunnel.
- Construction of two new large diameter access shafts, a 44’ x 60’ subsurface regulator chamber and odor control facility. The regulator has the ability to separate dry weather flow which is sent to the MCES treatment plant. If excessive flows are experienced because of wet weather infiltration and inflow, the excess can be bypassed so the treatment plant is not overwhelmed and flooded. This bypass is normally closed and must be manually opened, unlike the existing tunnel which utilizes a flow splitter and is always open.
- Subsurface connection of the new tunnel to the existing I-MN-340 interceptor on the east side of Hwy 55 and north of Minnehaha Parkway.

Figure 3 – Project Location Relative to Camp Coldwater Spring – both Highlighted



CNA, 2014

Figure 4 – Approximate Vertical Joint Locations Associated with Camp Coldwater Spring in Project Vicinity



Braun, 2014

Figure 5 – Approximate Vertical Joint Locations Relative to Project Features

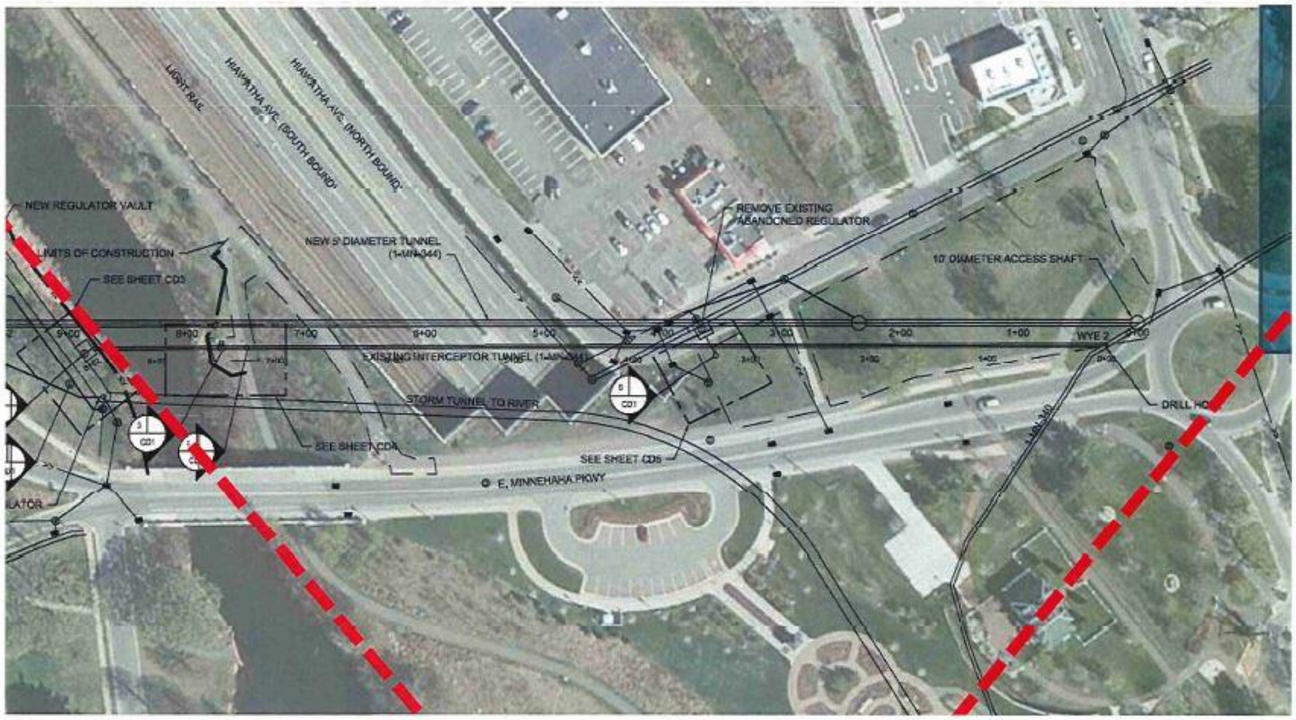


Figure 9. Location of hydraulically prominent joints, compared to the location of the tunnel features (base map from Brown & Caldwell)

Braun, 2014

The hydrogeology features affecting spring flow in this area are (1) the presence of a major vertical bedrock joint and (2) a basal Magnolia sub-formation discontinuity of the Platteville limestone. The exact location and nature of these features are unknown but inferred from other projects, borings, wells, etc.

PROJECT CONSTRUCTION

The project will involve several different phases which will involve different interactions with the basal Magnolia sub-formation discontinuity of the Platteville limestone and the potential with major vertical bedrock joint.

Braun Intertec, for Brown and Caldwell, the design consultant for MCES, has modeled the different project phases and its interaction with groundwater flow in the project area. In the evaluation they analyzed impacts associated with temporary dewatering during construction, penetration of the confining shale layer for the access shafts and groundwater flow once the project was completed. Based on the analysis of proposed construction activities the potential risk for permanent and measurable impacts to Camp Coldwater Spring are low based upon what is currently known about its supporting hydrology. It is doubtful if there is a temporary reduction it would even be measurable by monitoring given the variability in the flow and minimal potential reduction in flow.

However, the specific conditions at the locations of the vault and access shafts are not known and could be different than what is currently known. If conditions are encountered which lead to a permanent reduction in flow to the CCS, Wenck and MCES are confident there are feasible ways to restore flow to the spring.

Disturbance and potential grouting in the project vicinity should be adequate to prevent long-term infiltration but minimized whenever possible. The limits and extent of the grouting to control infiltration of groundwater from the Platteville limestone to the St. Peter Sandstone will be based upon the actual conditions and geology encountered during construction. Use of grouting to seal the existing confining layer of shale once the access shafts have been constructed is a reliable method of construction to maintain groundwater in the Platteville formation.

MCES is also taking steps to minimize the construction impacts:

- Extent of grouting will be reduced by enhanced application methods
- Some construction activities will be completed wet, thereby reducing the amount of dewatering

A qualified hydrogeologist familiar with Camp Coldwater Spring should observe disturbing activities, particularly physical disturbance and grouting while construction is proceeding, and prepare documentation of actual construction.

A description of construction activities which will interact with the Platteville limestone are highlighted below:

<u>Access Shafts</u>

The two large diameter access shafts penetrate the confining shale layer below the Platteville limestone, which accounts for almost all horizontal transmissivity in the formation. Only minor grouting is expected to be needed for the installation of these shafts and is a reliable method to seal the confining shale layer.

Although not planned, some dewatering may be required during advancement of the large diameter access shafts. The quantity/rate of temporary dewatering will be monitored and reported on a weekly basis along with flow from Camp Coldwater Spring. According to a groundwater model developed by Braun, a minor temporary reduction of spring flow could result. However, flow is expected to return to ambient conditions after dewatering ceases.

<u>Horizontal Tunnel</u>

The tunnel is located in the St. Peter sandstone beneath the Platteville limestone. Two to three dewatering wells will be used to facilitate construction of the new horizontal tunnel. The St. Peter sandstone does not contribute water to the spring and therefore should not cause any impact to the spring.

Regulator Vault
Installation of the regulator vault will occur near the basal portion of the Platteville Limestone. The vault elevation coincides with the basal Platteville and has the potential to intercept the Northwest to Southeast trending vertical joint(s). Therefore, construction dewatering and grouting of fractured rock around the vault has potential to produce an impact, but based on existing information and modeling completed by Braun the potential for risk is low. If conditions are encountered which lead to a permanent reduction in flow to the CCS, Wenck and MCES are confident there are feasible ways to restore flow to the spring. Grouting must be held to a minimum for construction of the vault and only temporary dewatering will be allowed.

MONITORING AND OVERSIGHT
The following activities will need to be accommodated as part of the project construction:

1. A MCWD representative (hydrogeologist) will need to be monitoring/observing construction activities related to shaft and vault construction, particularly in the Platteville Formation, to document actual geology and hydrology support features encountered. If unexpected conditions such as preferential flow paths, joints and other features that may represent hydrology support to Camp Coldwater Spring are encountered, the MCWD hydrogeologist will participate in reviewing response activities.
2. As part of a monitoring at Camp Coldwater Spring, MCES should monitor and report daily dewatering rates, volumes and locations, and report weekly results for all dewatering activities.
3. In addition, monitoring frequency of Camp Coldwater Spring flow should be increased to daily measurements, preferably involving the techniques, personnel and equipment presently used by the National Park Service. The increased monitoring frequency should begin before construction begins and continue until after substantial completion, with weekly results reporting.

MITIGATION/RESPONSE

If monitoring determines flows have been permanently impacted at Camp Coldwater Spring, the applicant has provided assurance that resources have been dedicated to contingency planning. MCES will be implementing a communication and response plan if flows at CCS have been implemented which provide the process for implementing mitigation measures. Because of the issues that could potentially be encountered remain purely speculative, the applicant has allocated resources to enact plans to address any difficulties.

If a response plan is needed it will be developed in coordination with the appropriate agencies based on the conditions encountered on the site which where unforeseen. An example of such a plan was the construction of the Hwy 55 and Hwy 62 interchange. Based on the physical conditions encountered it was determined the project would lower ambient groundwater levels and changed gradients in the close proximity of Camp Coldwater Spring, impacting or eliminating approximately 30% of the hydrologic support to the spring. Studies then conducted by MCWD consultants concluded there would be a permanent measureable reduction of the spring flow if the project proceeded as planned. MCWD District Engineer recommended a geosynthetic liner be installed under the intersection to isolate highway subdrains and storm pipes from the shallow groundwater.

An assessment of the monitoring data collected after the highway and liner construction was completed indicates the liner is functioning well and there has been no reduction of flow attributed to the highway. MnDOT believes the liner currently functions as one of the primary protective counter-measures taken to assure that Coldwater Spring was not negatively impacted by construction.

REFERENCES

Braun Intertec – Hydrogeological Analysis of Future Tunnel Vicinity, to Brown & Caldwell and CNA*,* October 20, 2014
CNA Consulting Engineers – 1-MN-344 Tunnel Improvements, Groundwater Control Measures, October 2104
C.R. Howe, modified 12/12/06, major fault and Camp Coldwater Spring highlighted for clarity

Mike Panzer, Vice President
Wenck Associates, Inc.
1800 Pioneer Creek Ctr.

Technical Memorandum

TO: Minnehaha Creek Watershed District
Eric Evenson, Administrator
Jim Hafner, Sr. Technician

FROM: Mike Panzer, P.E., P.G.
District Engineer

DATE: February 8, 2005

SUBJECT: Update on Camp Coldwater Spring Flow

CC: John Thene, P.E.

I have acquired MnDOT monitoring data from 2003-2004 relative to Camp Coldwater Spring, including flow at the pool outlet of the spring; flow from the drains interior to the geosynthetic clay liner under Hwy 62 at the intersection with Hwy 55; and MnDOT dewatering discharge records during construction activities. Precipitation records were also acquired from MSP Airport. These data were acquired because you have requested an updated report on interpretation of the monitoring data. Specifically, you requested an evaluation of whether the liner under the Hwy55/Hwy62 interchange has been successful in protecting the groundwater flow regime, which generally sustains the spring flow.

Figure 1– Camp Coldwater Spring Pool Outlet Flow

A nearly complete record of the spring pool outlet flow, beginning in the summer of 1998, is shown in Figure 1.

As can be seen from data plot, there is an appearance of a gradual downward trend in flow over the past 6 or 7 years. However, it is important to note that the method of measuring flow changed in late 2002. The early flow data are derived from manual and discreet measurements of volume over a short time interval, by several different people. The latter data are derived from continuous pool level measurements using dedicated equipment, which are converted to flow by means of a calibrated rating curve. Manual measurements taken earlier in the record probably over-estimate flow from the spring. The probable over-estimation of flow was observed when both methods of measurement were conducted simultaneously. Therefore, any trend may be exaggerated in the data plot because of the apparent bias in the early data record. It is also important to note that several other natural factors affect the flow rate, such as seasonal variations, precipitation and natural groundwater level fluctuations. Highway construction dewatering has also artificially reduced spring flow in 2001 and 2003.

Figure 1- Camp Coldwater Spring Pool Outlet Flow

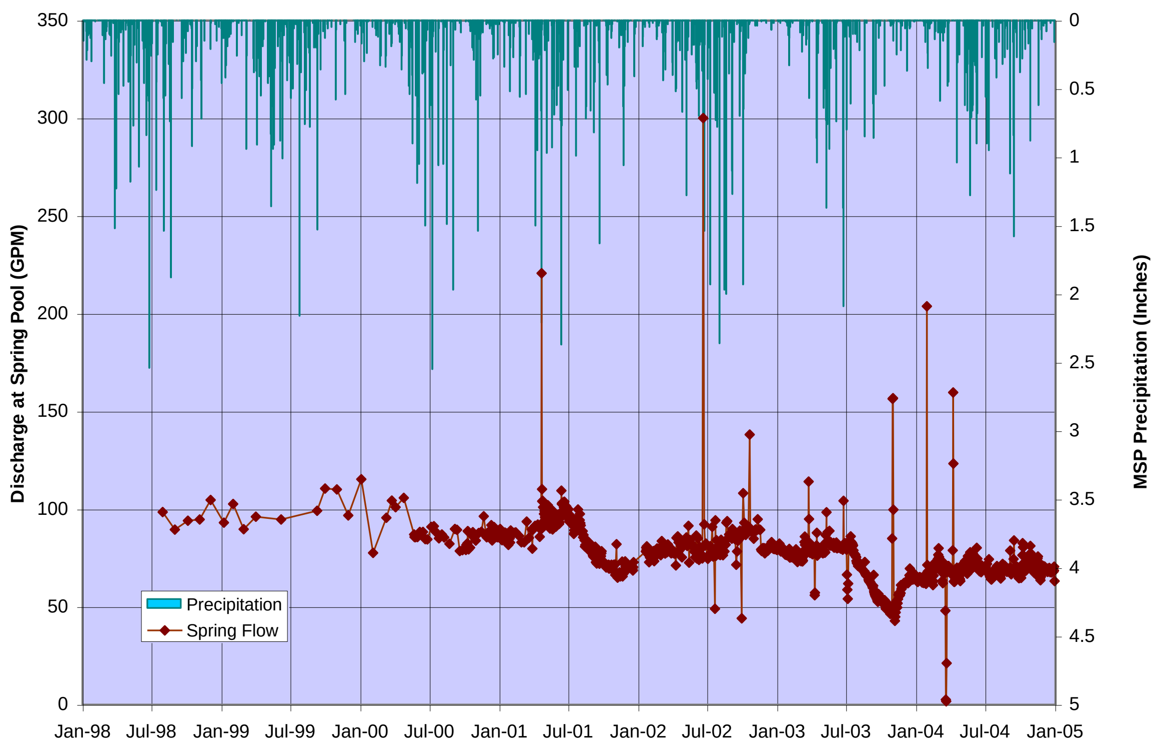
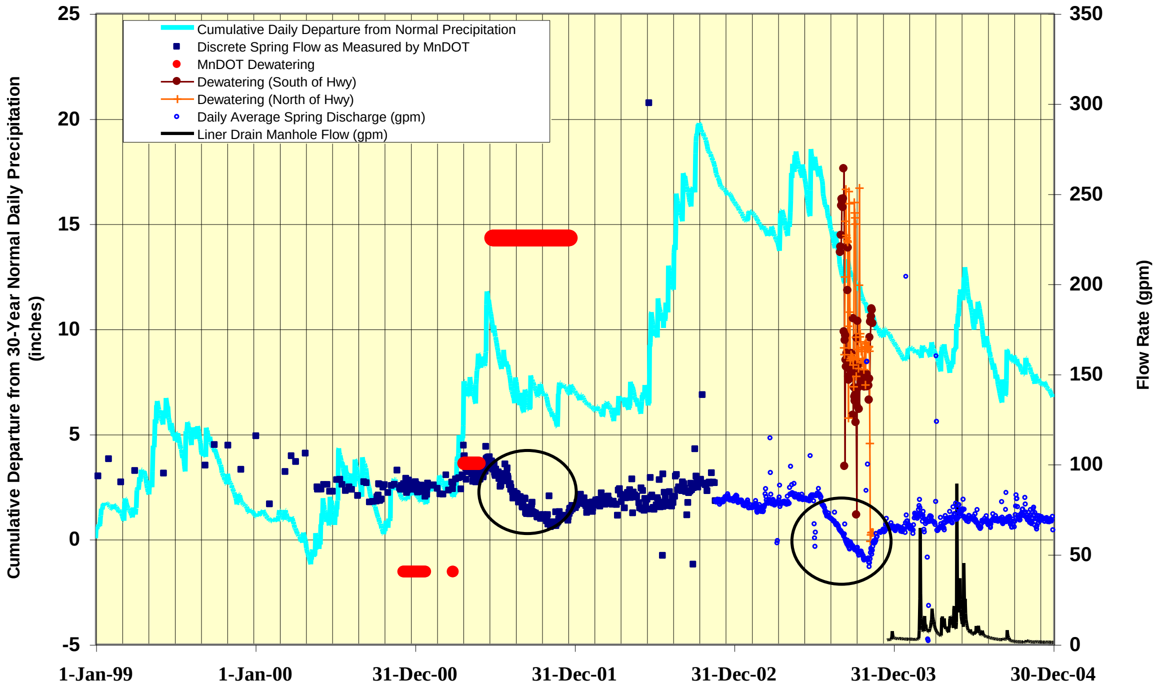


Figure 2– Comparison of Camp Coldwater Spring Flow Rate, MnDOT Dewatering Events, and Cumulative Departure from Daily 30-Year (1971-2000) Normal Precipitation

The pumped withdrawal of groundwater from the area of the highway intersection during construction has had noticeable effects on spring flow. Construction dewatering has been occasional, with pumping exceeding 150 gallons per minute in the summer-fall of 2001 and again in 2003. During these two periods of construction dewatering there was a responsive and sustained reduction in spring flow of 30-40 gallons per minute as illustrated in Figure 2 on the next page.

Figure 2 - Comparison of Camp Coldwater Spring Flow Rate, MnDot Dewatering Events, and Cumulative Departure from Daily 30-Year (1971 to 2000) Normal Precipitation



During other periods of construction dewatering, when the pumped withdrawal of groundwater less than 150 gallons per minute, a discernable reduction in spring flow could not be observed.

<u>Discussion</u>

The original road design of the Hwy55/Hwy62 intersection included proposed drains located at the base of the road subgrade. The purpose of these underground drains was to collect and discharge infiltrated precipitation and groundwater, thereby keeping the road subgrade dry. This is a standard design feature needed in this type of climate to minimize frost action and road surface maintenance requirements. These proposed drains were below ambient groundwater levels. It was the position of MCWD that the proposed subgrade drains would permanently intercept and discharge significant volumes of groundwater and permanently lower ambient groundwater levels near the spring. This presented an unacceptable risk of reducing spring flow on a long-term basis.

MCWD took a firm position and insisted a design change was needed to protect spring flow. Mainly, that the needed subsurface drains be isolated from the ambient groundwater table, so that they only collected and discharged infiltrating precipitation and not groundwater. The monitoring data from 2001 construction dewatering was clear that significant removal of groundwater at this location could affect spring flow. It was likely that permanent subsurface drains below the ambient groundwater level could produce the same effect that the construction dewatering did in 2001.

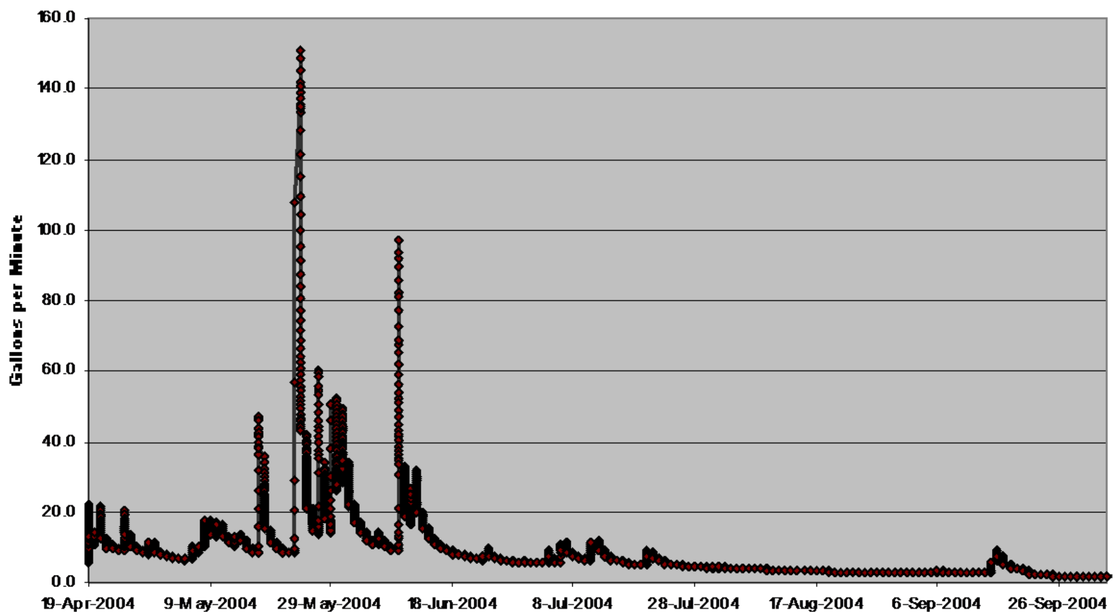
MnDOT responded and the intersection design was changed to include an impermeable liner that isolates the road subgrade (and subdrains) from the surrounding groundwater. The liner was installed in the Fall of 2003. When construction dewatering occurred in 2003, a similar sustained reduction of flow from the spring was again observed, as it was in 2001.

MnDOT also agreed to install dedicated sensors designed to measure the discharge from these subdrains on a continuous basis.

Figure 3– Hwy 55/Hwy 62 Intersection – Interior Liner Drain Flow

Figure 3 shows the measured flow in the road subdrains (also shown in Figure 2), beginning when the dedicated monitoring equipment was installed. Prior to June 2004, flow in the drains was erratic and sensitive to precipitation because construction was ongoing and the paving of the road was not completed. After June 2004 the subdrain flow substantially receded and has been much less erratic, indicating the completed paving has greatly reduced infiltration and the liner is effectively isolating the subdrains from the ambient groundwater table.

Figure 3 - Hwy 55/Hwy 62 Intersection Interior Liner Drain Flow



Conclusion

Flow the Camp Coldwater Spring pool has been steadily in the 70-75 gallons per minute range for approximately the last year and a half (see Figure 2). That is the period of time where there has been no construction dewatering, the liner has been in-place and the road has been paved. Discharge from the subdrains, after completion of the liner and road paving, has dropped to a range of 1 or 2 gallons per minute during dry weather. These data thus far indicate the impermeable liner has been successful in preventing groundwater from entering the subdrains. Monitoring of the spring pool outlet flow, road subdrain discharge, nearby groundwater levels and precipitation should continue beyond when MnDOT will cease their monitoring activity associated with road construction. Camp Coldwater Spring is a valued water resource within the boundary of MCWD, and previous MCWD studies have indicated an importance of the eco-systems supported by bluff spring environments. Therefore, the District should support continued monitoring.

Minnesota Department of Transportation

Office of Environmental Stewardship
Mail Stop 620, 395 John Ireland Boulevard
St. Paul, MN 55155
Office Tel: (651) 366-3633

December 5, 2014

To: Sarah Beimers, Manager
Review and Compliance Section
Minnesota Historical Society

Dr. Scott Anfinson, State Archaeologist
Office of the State Archaeologist
Department of Administration

RE: MnDOT Compliance with Chapter 101-S.F.No. 2049 Regarding Flow of Water To or From Camp Coldwater Springs.

MnDOT's Cultural Resources Unit conducted a review of Permit M-UL-2013-59722 in April of this year, as per the terms of M.S. 138.40 and 138.665. As we were in the review process, we were notified of Chapter 101-S.F. No. 2049, which states that:

> "Neither the state, nor a unit of metropolitan government, nor a political subdivision of the state may take any action that may diminish the flow of water to or from Camp Coldwater Springs. All projects must be reviewed under the Minnesota Historic Sites Act and the Minnesota Field Archaeology Act with regard to the flow of water to or from Camp Coldwater Springs."

As archaeologists and historians, our unit felt unable to determine what construction activities could impact the hydrology of the area. I requested that MnDOT's hydrologists study the issue and make a recommendation about the areas in which work could impact the flow of water to and from the spring. Enclosed please find the report containing recommendations regarding the vertical and horizontal areas in which projects could impact the flow of water to and from the spring.

MnDOT plans to use the recommendations in the enclosed reports to determine if a project has the potential to impact water flow. MnDOT is creating a GIS layer with the proposed boundaries so project planners in the Metro District and the Permits office will know if their project is in the area of concern. They will then contact our office so we can review the project as per M.S. 138.40, 138.665, and Chapter 101-S.F. No. 2049.

Please let us know if you have any questions or concerns, or would like to meet to discuss. We also look forward to receiving any comments from MNRRA and the Minnehaha Creek Watershed District.

Sincerely,

Kristen Zschomler

Kristen Zschomler, Historian and RPA-Registered Archaeologist
MnDOT Cultural Resources Unit Supervisor

cc: John Anfinson, Chief, Resource Management, MNRRA
Chris Meehan, Regulatory Program Manager, Minnehaha Creek Watershed District
Dave Seykora, MnDOT Legal Staff
Ann Driver, MnDOT Permits
Lynn Clarkowski, Director, MnDOT Office of Environmental Stewardship
Rick Dalton, MnDOT Metro
MnDOT CRU files

Safeguarding Coldwater Spring

Requirements for Projects Conducted on MnDOT Right-of-Way

July 31, 2014

Camp Coldwater Springs – A Protected Resource

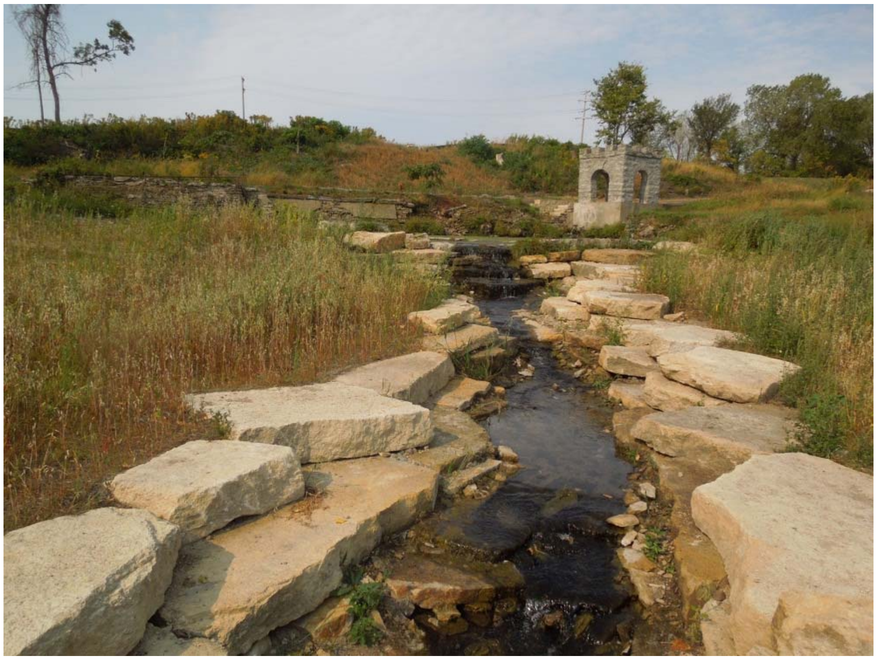


Figure 1 - Coldwater Spring 2013, Site Restoration by the National Park Service.

Protecting the flow from Camp Coldwater Springs became a contentious debate during construction of the TH55 and TH62 interchange beginning in 2000. The construction plan included an underpass for TH62 which would have required a permanent lowering of the surficial (perched) water table in the vicinity of Camp Coldwater Springs. At the urging of the Minnehaha Creek Watershed District (MCWD), a State Statute[1] was enacted in 2000 that provided "Protection of Natural Flow" for "Camp Coldwater Springs". In response to this statute, the construction project was altered by raising the profile grade slightly and constructing a special water proof liner to permanently depress the water table without requiring permanent groundwater removal. In 2001, the description of the protection of the flow was changed in the Statute to read:

> "*Neither the state, nor a unit of metropolitan government, nor a political subdivision of the state may take any action that may diminish the flow of water to or from Camp Coldwater Springs. All projects must be reviewed under the Minnesota Historic Sites Act and the Minnesota Field Archaeology Act with regard to the flow of water to or from Camp Coldwater Springs.*"

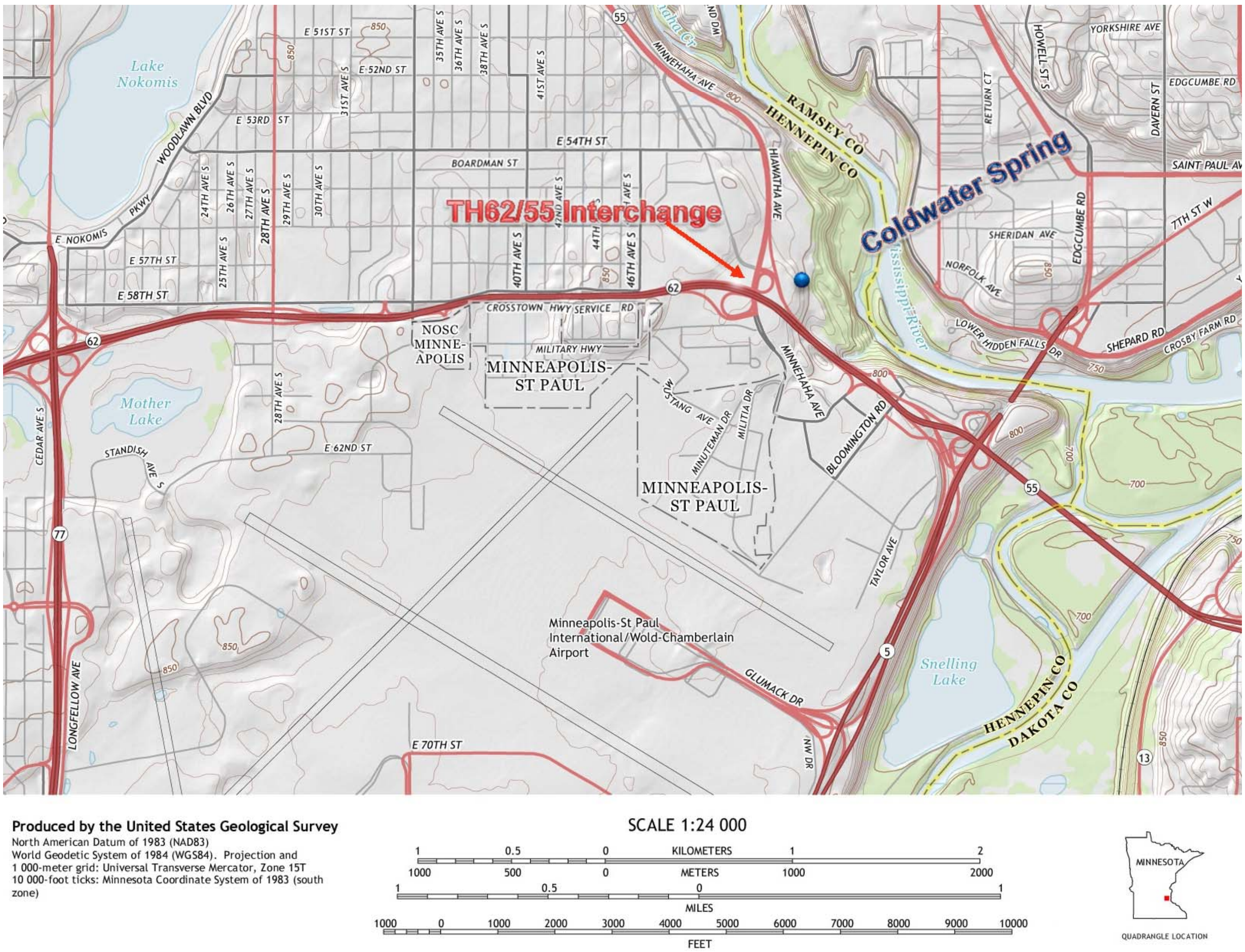
The MnDOT Cultural Resources Unit (CRU) has interpreted this new language to mean that all projects taking place on MnDOT right-of-way must be reviewed by CRU for compliance to the requirement that the intended project does not diminish flow to or from Camp Coldwater Springs. This report is intended to serve as a guideline to assist Cultural Resources in making decisions concerning the potential for impact to Camp Coldwater Springs for the purpose of granting or denying approval of future projects.

[1] Minnesota Statute 2000, section 138.73, subdivision 13.

Coldwater Spring – Location and Definition

> *"Camp Coldwater is an area of several springs that are important to Native Americans, as well as an early European settlement in the state of Minnesota, USA. Camp Coldwater is located adjacent to the Mississippi River in south Minneapolis, directly south of Minnehaha Park."*[2]

Figure 2 - Location of Coldwater Spring and proximity to the Mississippi River Gorge and the TH62/55 Interchange.



There are several springs and seeps that flow out of the ground within the former U. S. Bureau of Mines property. The author has identified at least 5 locations where groundwater is reaching the surface and is either ponding or flowing across the property to the Mississippi River gorge. The largest of these "springs" flows out of the "Historic Springhouse" (figure 1) into the "Historic Coldwater Reservoir". Approximately 150 feet south of the main spring, water seeps out of the ground along a topographic break in the landscape. The 100 foot long seepage area (referred to as "Wetland A" by the NPS) used

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[2] "Camp Coldwater" from Wikipedia http://en.wikipedia.org/wiki/Camp_Coldwater

to contribute some flow to the Coldwater reservoir, but now is directed to a constructed channel that flows east across the park and eventually unites with the water from the Coldwater reservoir (figure 3).

Figure 3 - Diagram of Coldwater Spring Area, courtesy of the National Park Service (modified by Howe). Spring terminology is added in yellow.

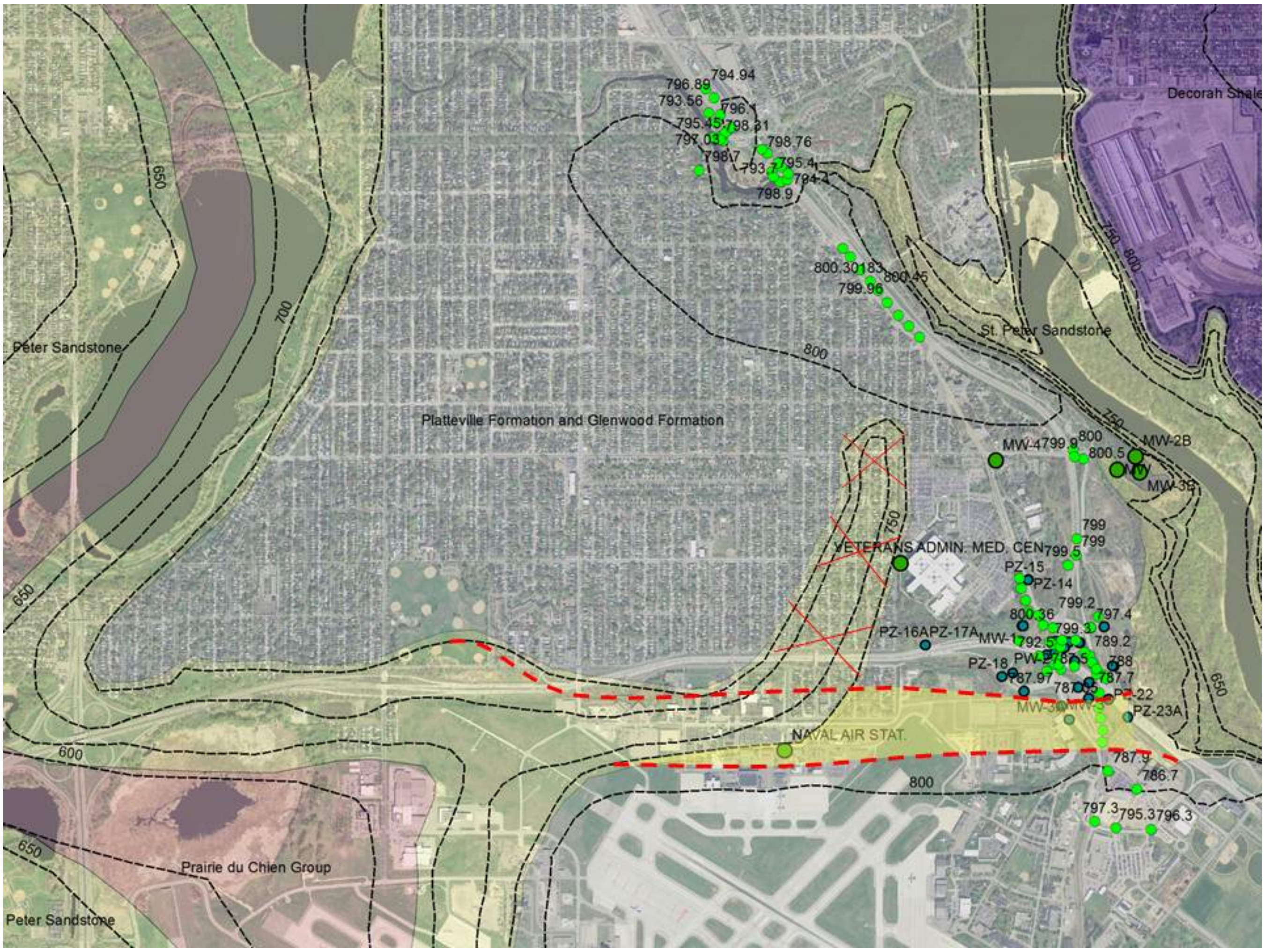
Figure 4 - Flow from Camp Coldwater Reservoir, May 2000

Flow has been measured since January 2, 2013 by the National Park Service at the "Springhouse" location and in the channel that drains "Wetland A". Flow from the "springhouse" has been between 35 and 47 gpm with the average of 41 gpm. Flow from "Wetland A" has ranged from 13 to 22 gpm with an average of 18 gpm. The two locations combine to produce about 60-65 gpm which is comparable to flow rates measured before the TH55/62 project began. When the "Camp Coldwater Springs" statute was passed, "spring flow" was being measured at a culvert that drained the Reservoir and included: 1) flow from the springhouse site, 2) partial flow from the seepage area south of the reservoir (now known as Wetland A), and 3) surface runoff from adjacent areas (which was substantial during heavy rainfall events). The Statute does not define what constitutes "flow from Camp Coldwater Springs" but by its wording implies that flow may be from more than one source. The current measurements being made by the NPS include flow from the Spring and from the next largest seepage area (Wetland A). Both of these sources were combined to some extent in the original Camp Coldwater Spring flow that was taken at the end of a culvert (figure 4) that drained the Coldwater Reservoir. Without further direction from the State, it seems prudent to include both of the current NPS measurements as the flow from "Camp Coldwater Springs".

Camp Coldwater Springs – Hydrogeology

The hydrogeology in the vicinity of the Trunk Highway (TH) 55 /TH62 interchange and adjacent Camp Coldwater Spring area is relatively straight forward in the regional view, but becomes more complex when you look at flow as it approaches the Mississippi River gorge. Regionally, groundwater flows from west to east and receives recharge from precipitation and lakes within its boundaries (such as Lake Nokomis and Mother Lake) and ultimately discharges into the Mississippi River. Bedrock plays an important role in the groundwater system because the St. Peter Sandstone is highly permeable and has its own flow regime but is capped by the Glenwood Shale and overlying Platteville Limestone which act as confining beds to downward migration of water into the St. Peter. In several locations, drainage valleys have been cut through the Platteville/Glenwood into the St. Peter Sandstone. These valleys were later filled with glacial sediment, but they allow groundwater levels in the St. Peter Sandstone to be in contact with the overlying surficial levels. The most recent bedrock map (see figure 5) published by the Minnesota Geological Survey (MGS) shows valleys cut into the St. Peter Sandstone to the west and south of the Coldwater site. The author has modified the bedrock map based on numerous borings taken in the TH55/62 Interchange area and at several bridge sites on TH62 west of the interchange. There seems to be little evidence for the bedrock valley that is shown turning north near the Veterans Center (crossed out on the map). There is however strong evidence that the east/west bedrock valley, south of TH62, continues through to the Mississippi River gorge.

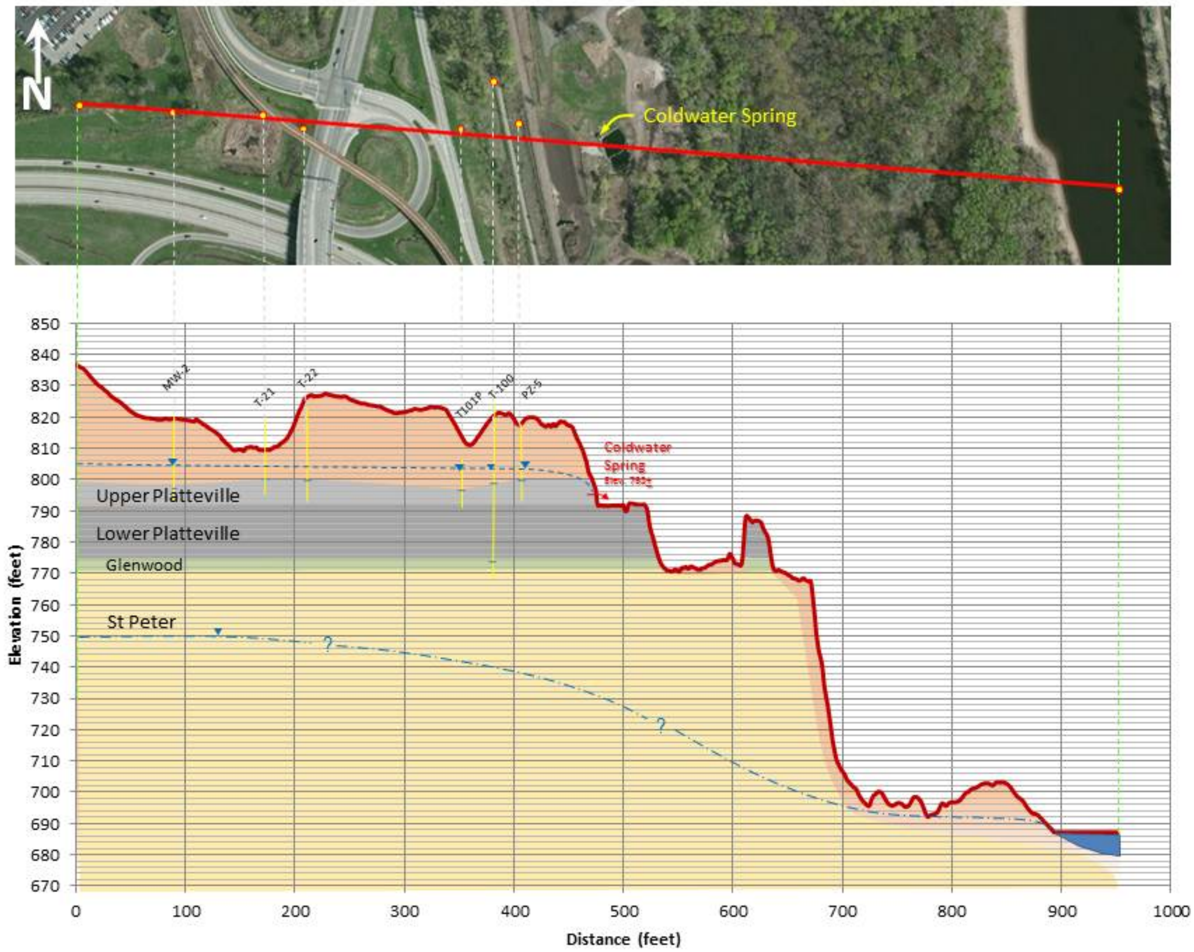
Figure 5 - 2013 MGS Bedrock Geology Map[3] with Boring Locations (Modified by Howe 2014)



Approaching the Coldwater area from the west, groundwater separates into the St. Peter bedrock aquifer which rapidly drops to the Mississippi River level (+688 feet) as it nears the gorge, and the surficial aquifer which remains high as it approaches the TH52/62 Interchange and Coldwater area (795-810 feet). Figure 6 is a cross section drawn nominally from west to east across the TH55/62 interchange, through Coldwater Spring and down to the Mississippi River. It shows the general stratigraphy of St. Peter Sandstone, overlain by +3 feet of Glenwood Shale, +26 feet of Platteville Limestone and assorted soils. The Platteville formation is generally thought to be 32 feet thick in this area, but it has been partially removed by erosion. For the purpose of groundwater discussions, the Platteville can be divided into Upper and Lower units based on hydraulic conductivity. The Lower Platteville contains 3 members (from lowest to highest); Pecatonica, Mifflin, and Hidden Falls. The Mifflin and Hidden Falls Members contain high amounts of shale (>30%) and act as a downward confining layer to the surficial groundwater. The Upper Platteville is made up of the (lowest to highest) Magnolia and Carimona Members that have considerably lower shale contents. These two members have enlarged bedding planes and joints due to groundwater dissolution and are able to conduct water quite readily in the horizontal direction.

[3] 2013 Miscellaneous Map Series Map M-194, Bedrock Geology, Ten-County Metropolitan Area by John Mossler

Figure 6 - Cross Section through Coldwater Spring and the TH55/62 Interchange



Coldwater Spring exists because of a combination of favorable factors. The confining nature of the lower Platteville serves to keep the surficial water levels artificially high as they approach the Mississippi River gorge. The enlarging of beds in the upper Platteville by groundwater dissolution has created a highly permeable horizontal flow regime which conducts water more rapidly than the overlying soils. And finally, the Mississippi River gorge truncates the Platteville plateau on the eastern side and allows water flowing in the upper Platteville to discharge at locations on the slope. Figure 7 illustrates the location of the Platteville plateau where it has been eroded by the Mississippi River on the east and by a bedrock channel on the south. In figure 7, the maximum lateral extent of the lower Platteville confining beds is shown in red, and the yellow line depicts the maximum lateral extent of the upper Platteville beds which serve as the conduit for open channel flow in the upper "surficial" water table. It probably shouldn't be called a surficial water table since it is flowing through both bedrock and unconsolidated material, but is serves to differentiate it from the bedrock flow system in the St. Peter. There are some granular soils and low permeability, non-granular soils overlying the bedrock, which influences the rate at which shallow water can descend to the more rapid flowing system in the limestone. These differences in soil types as well as topographic differences combine to produce a non-uniform water level across the site.

Six different seepage areas/springs have been observed in the Coldwater Spring area which is related to the truncation of the Platteville shelf. These seepage areas are shown in figure 7 as blue arrows. At locations where the upper Platteville is exposed at the surface (Coldwater Spring & the northern most spring), water discharges at a significant rate since there are little or no soils to impede flow. The remaining seepage areas have lower flow because the Platteville is covered by soils that the water must pass through in order to discharge to the surface. It is quite likely that there are other areas along the edge of the plateau where water exits the Platteville but then descends through the surficial soils to the St. Peter.

Figure 7- Coldwater Area showing Eastern Terminus of the Platteville Plateau (Red dotted pattern) – Yellow dashed line is edge of the Upper Platteville and the Red Dashed line is the edge of the lower Platteville.

Protecting the Spring

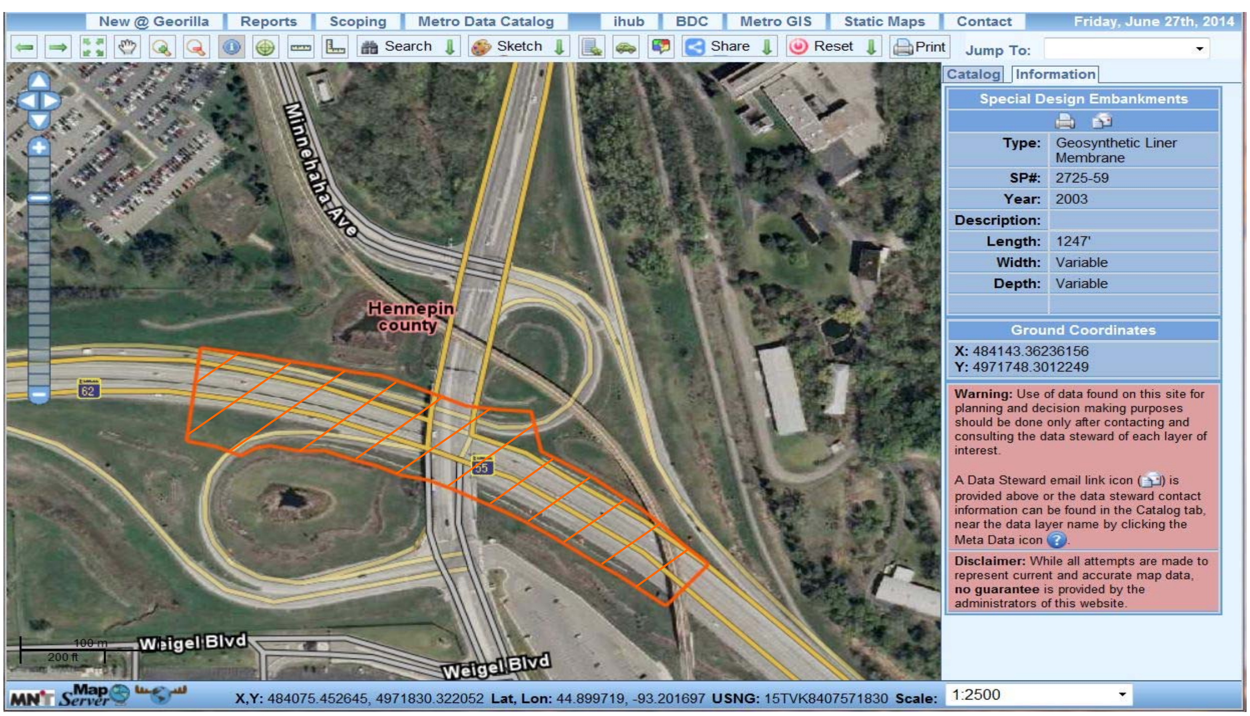
Three features have been recognized as needing some level of protection to assure that Coldwater Spring is not negatively impacted by projects that may take place on MnDOT Right-Of-Way (ROW). These three features are: 1) the Geosynthetic Liner System at the TH55/TH62 interchange, 2) the unique flow regime of the Platteville limestone, and 3) surficial groundwater levels up gradient from the spring. All three of these features have differing sensitivities and need to be considered how they may be affected by future projects on MnDOT ROW.

Geosynthetic Liner System

The Geosynthetic Liner System (GLS) was constructed in the TH55/TH62 interchange and is completely contained within MnDOT ROW. The GLS consists or multiple layers of geotextile, coarse filter aggregate, geomembrane and geocomposite drains that were constructed to depress the groundwater levels in the interchange to facilitate the lowering of the TH62 grade under Bridge 27R02 and the Light Rail Transit track. The liner is present below grade everywhere in the hachured polygon shown in figure 9, at depths ranging approximately between 1 to 10 feet. Compromising the GLS could result in a significant volume of water entering the TH62 surface drainage system and being directed away, thus potentially reducing groundwater levels in the spring source area. <u>No construction should be allowed to take place in this zone</u> without approval by the Geotechnical Engineering Section. This includes activities such as drilling, trenching, pile driving or excavating. Repairs or rehabilitation of the pavement may be approved if confined to the pavement structure. Bridge 27R02 is not included in this advisory, except for the center piers which are mechanically connected to the liner. Warning signs appear along the roadway with the warning not to dig in the area (see figure 8), but in general, the liner system is poorly marked in the field.

Figure 8 - GLS Warning Sign

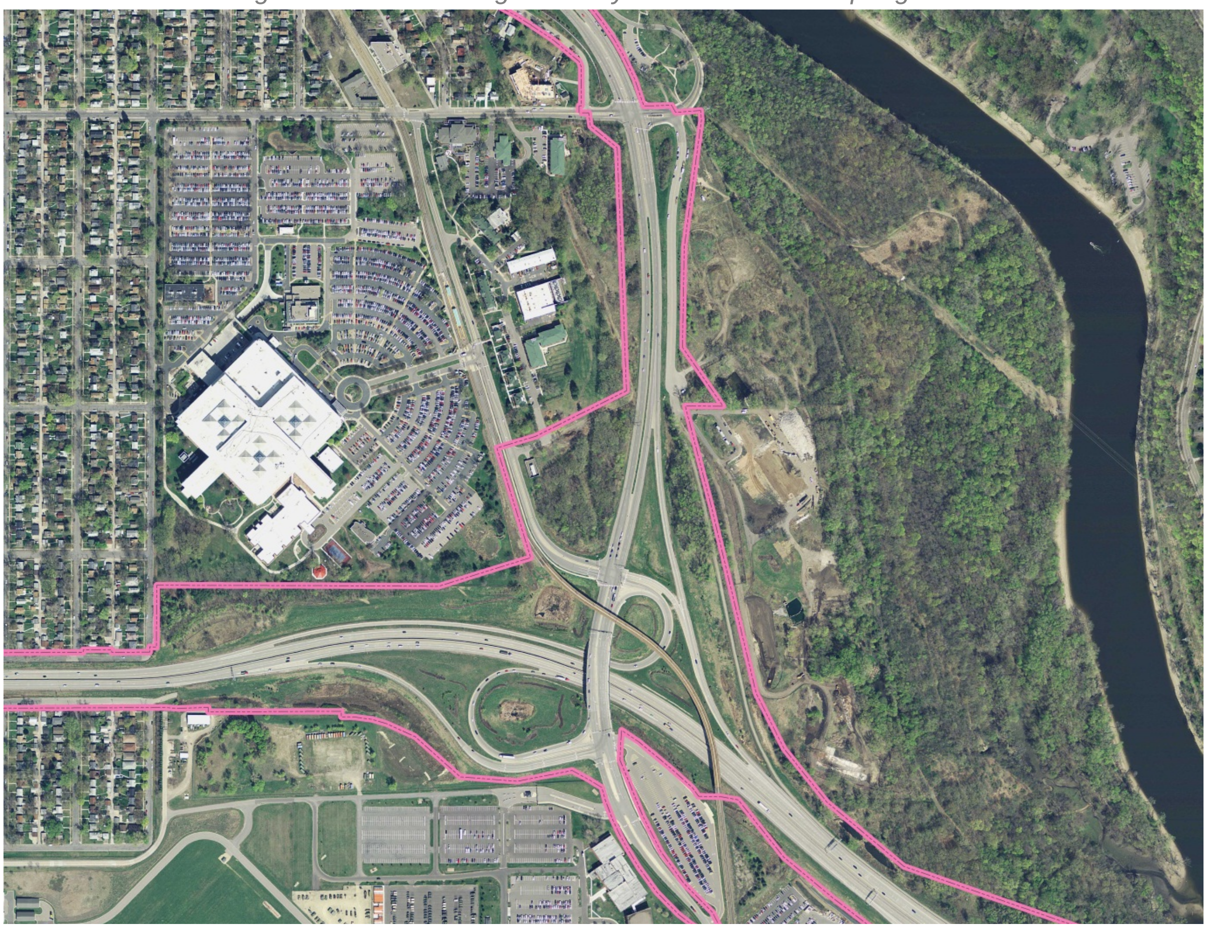
Figure 9 - Location of the Geosynthetic Liner System as Given on the MnDOT "Georilla" Website



Platteville Limestone Flow Regime

As discussed previously, Coldwater Spring owes its existence in a large part to the Platteville Limestone, where the lower members act as a confining bed to downward flow, and the upper members with their high horizontal permeability, function as the main conduit for flow to the spring. The Platteville is truncated on three sides (see figure 5) which limits the area where there needs to be concern about disturbing it. The potential area of concern is also limited by MnDOT ROW since this document is meant as an advisory for projects that may take place on that right-of-way. The ROW is shaped by two highways that nominally form a tee just west of Coldwater Spring. In the area of their intersection the ROW of fairly large, up to 900 feet at the widest, and narrows appreciably (<200 feet wide) as the two highways leave the interchange area (see figure 10).

Figure 10 - MnDOT Right-of-Way in the Coldwater Spring Area

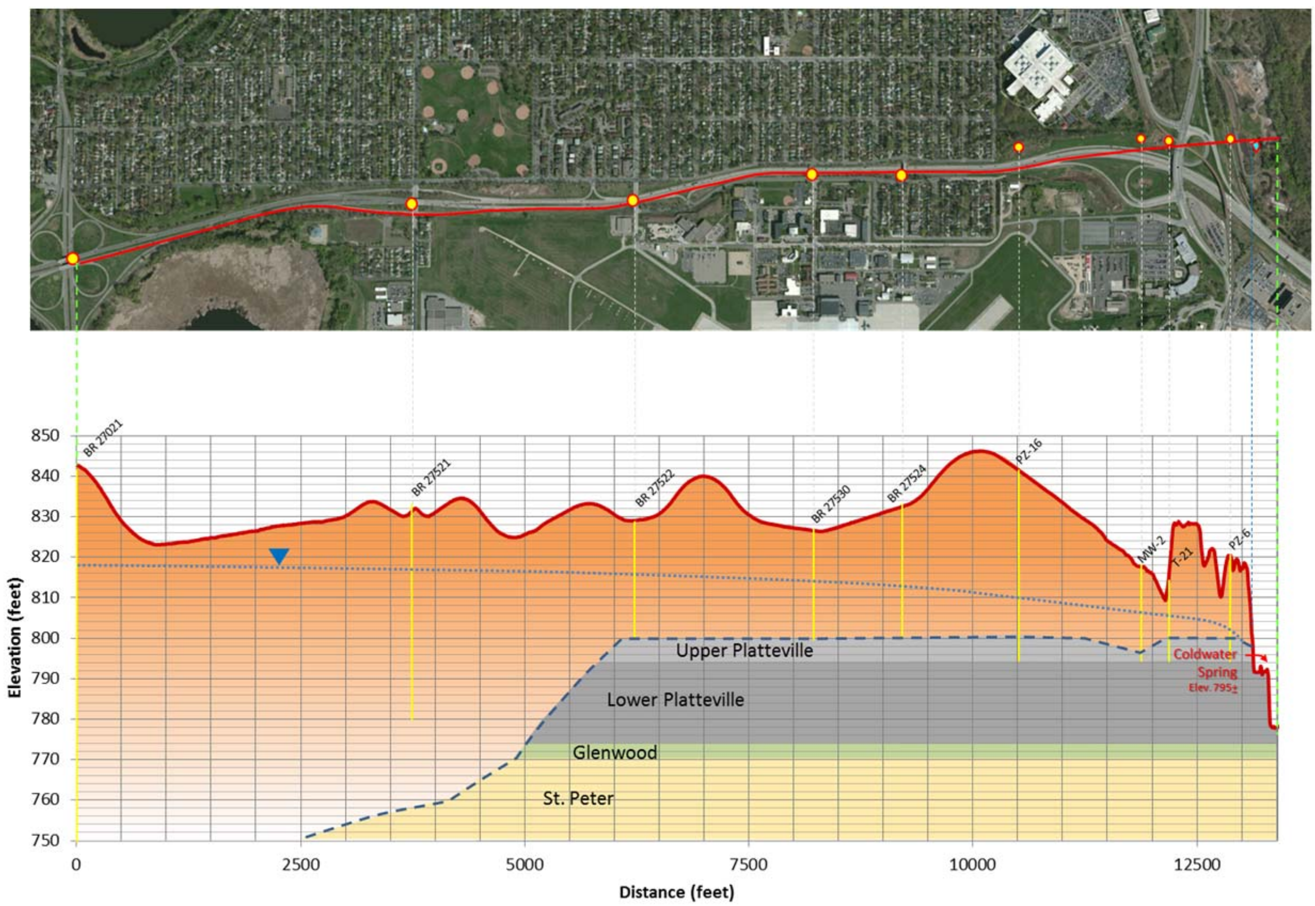


Platteville Limestone is typically found around elevation 800 feet in the interchange area and can be as high as 806 feet on the far north end of the project. The contact between the “Upper Platteville” (Carimona and Magnolia Members) and the “Lower Platteville” (Hidden Falls, Mifflin and Pecatonica Members) is placed at elevation 794± feet. Care should be taken to avoid any projects that would “disturb” the Upper Platteville in the area of the interchange. Disturbance is a relative term and should not be treated equally across the site. As distance from the spring increases, sensitivity to disturbance of the Upper Platteville will decrease. The direction is also important since the flow to the spring comes nominally from the west. The critical area where all types of encroachment into the Platteville should be avoided is set at 1500 feet to the west, 1000 feet to the north, and about 500 feet to the south (See Advisory Diagram 1). Beyond the critical zone, care should still be taken to avoid large areas of excavation in the Platteville, or projects that would penetrate the entire thickness of the Platteville and Glenwood Shale and allow rapid groundwater movement into the underlying St. Peter Sandstone.

Surficial Groundwater Levels Up Gradient from the Spring

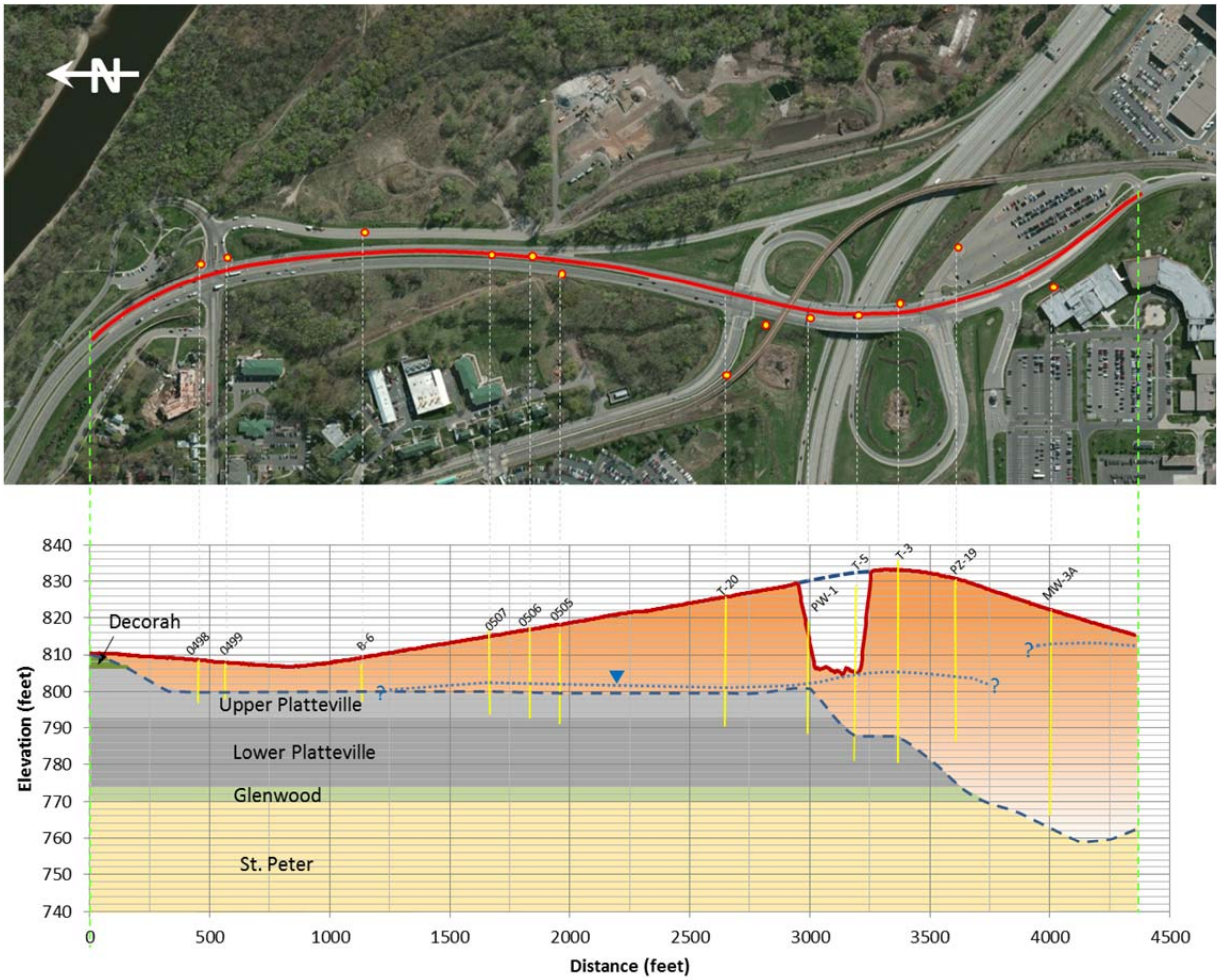
Surficial groundwater flows nominally west to east across the site and is perched on the Lower Platteville and Glenwood Shale layers. Near Mother Lake (west of the Spring) water levels are around elevation 818 feet and drop consistently until they reach elevation ±800 feet as shown in Figure 11. The groundwater levels are more consistently around elevation ±800 along TH55 to the north of the intersection and Coldwater Spring (figure 12). South of the intersection, the Platteville Limestone is absent, and much of the preexisting erosional valley has been filled in with heavy, cohesive soils which don't readily transmit groundwater. Water levels are higher near the entrance to the Army Reserve Command headquarters, but this perched system is not connected to groundwater in the interchange area and consequently, will not affect Coldwater Spring.

Figure 11- Geologic Cross Section Along TH62 from TH77 to Coldwater Spring.



A vast amount of water is contained in the surficial soils and underlying permeable layers of the Upper Platteville Limestone up gradient from Coldwater Spring. Clearly this water does not all discharge through Coldwater Spring. During construction of the interchange, many areas of granular lenses and beds were exposed where varying amounts of water discharged at low to moderate rates. Most of these areas were in the southeast portion of the interchange where construction was deep enough to encounter the groundwater.

Figure 12 - Geologic Cross Section along TH55 from South of TH55/TH62 Interchange to North of 54 St E.



To protect the flow regime at Coldwater Spring, the source for the spring flow must be protected. It cannot be known for certain what level of impact there might be to the spring flow if water is withdrawn or diverted up gradient of the spring unless an aquifer test of some nature is conducted. To say that no water can be removed from the perched aquifer system in the area of the TH55/TH62 interchange would pose an unnecessary restriction for future projects. It is recommended that projects be allowed to withdraw groundwater from the area on a temporary basis with the possibility to become permanent if no impact is seen in the monitoring data taken by the park service.

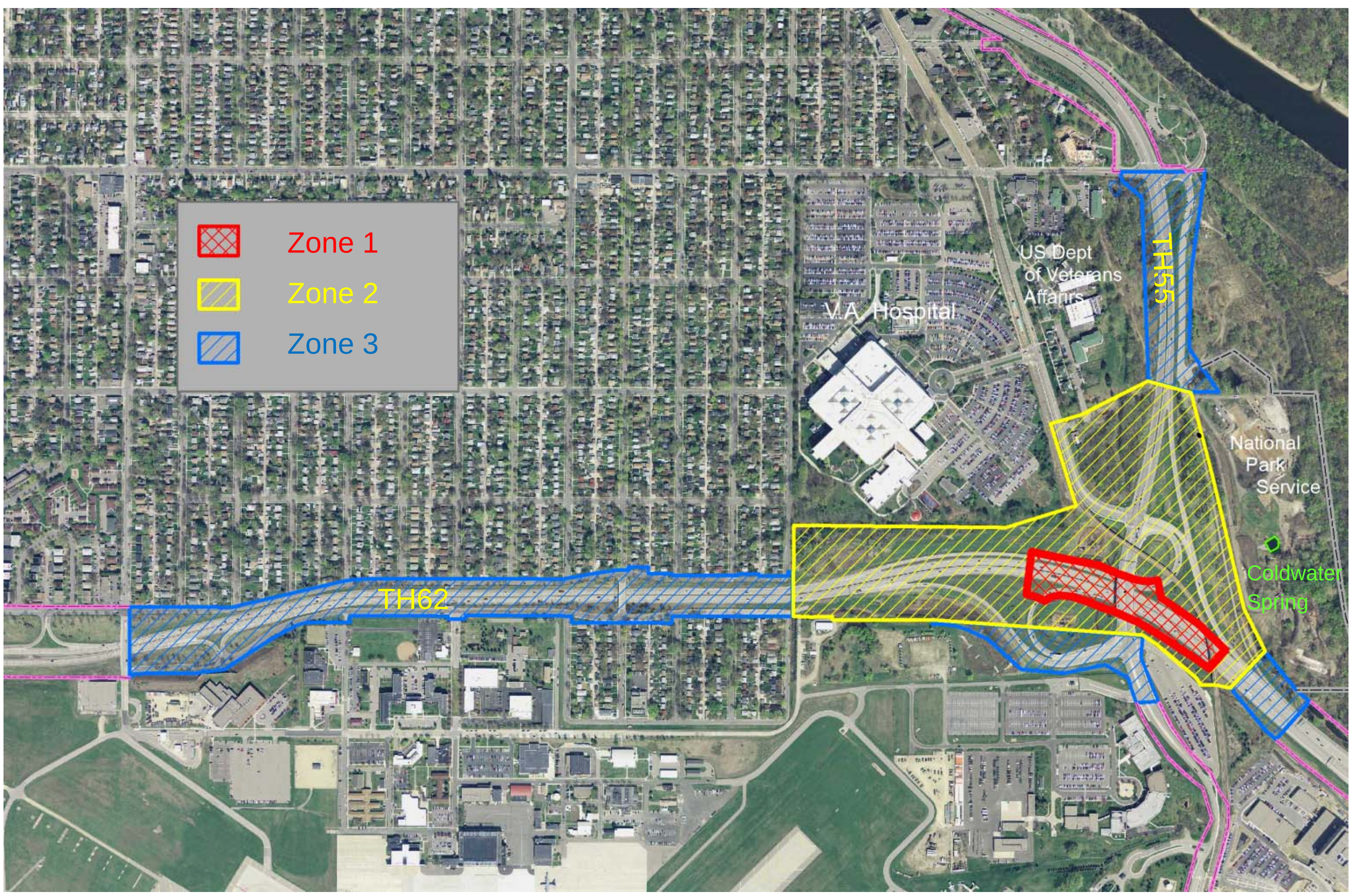
Recommendations

Recommendations from this section may be used as a screening tool to determine if specific projects that are proposed to take place on MnDOT ROW in the vicinity of the Coldwater Spring, will be granted clearance from the Cultural Resources Unit. The recommendations are in the form of a "sensitivity" map (figure 13) and a descriptive summary. Details are intentionally left out of the summary to make it a practical reference. Questions concerning the recommendations should be addressed to the Geotechnical Engineering Section. Figure 13 depicts three zones of differing sensitivity for potential impacts to Coldwater Spring and offers appropriate safeguards for diminishing the possibility of such impacts:

Zone 1 is a Geosynthetic Liner System which must not be compromised. No construction activity should take place in this zone without approval from the Geotechnical Engineering Section. Repairs or rehabilitation of the pavement may be approved if confined to the pavement structure.

Zone 2 is the area where both the Platteville Limestone and the surficial groundwater system need to be protected. Construction may be allowed to take place in the surficial deposits (typically 15 to 30 feet deep), but excavation into the limestone should be avoided. Drilling vertical boreholes into the limestone may be permitted on a limited basis but schemes that would include multiple borings in a small area, such as a secant wall, should not be permitted. Temporary dewatering of the surficial soils may be permitted in Zone 2 for a short duration (up to 30 days) and for a limited volume (30 gallons/minute) without an in-depth hydrologic study. Any projects that propose to exceed either of these criteria will be required to produce a study to show what potential impact the temporary dewatering will have on Coldwater Spring. The study results and any mitigating measures must be approved by the National Park Service (NPS) and the Minnehaha Creek Watershed District (MCWD) before the project will be allowed to proceed. No permanent dewater should be permitting in Zone 2.

Figure 13 - TH55/TH62 Interchange Area with Delineated Zones of Protection for Coldwater Spring



Zone 3 includes four separate areas that are not considered sensitive to disturbance in the Platteville Limestone, but are sensitive to dewatering of the surficial deposits. The western-most area (TH62 between 46th Ave S and 34th Ave S) is essentially up-gradient from Coldwater Spring and the other three areas of Zone 3 sensitivity are essentially beyond the normal flow regime of the spring. Short-term dewatering (up to 60 days and 50 gpm) will not have an impact on Coldwater Spring and should be allowed. Longer term or higher volume dewatering schemes may lead to a decline in water levels in Zone 2 and thus should not be allowed without a similar study (as outlined in Zone 2 recommendation above) and approval of the stakeholders (MnDOT, NPS and MCWD).

For More Information

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beth.lauzon@state.mn.us

Prepared by: Chuck Howe, PG, Chief Engineering Geologist, Office of Materials & Road Research
Beth Lauzon, PG

BRAUN INTERTEC

The Science You Build On.

Memo

Date: October 20, 2014

To: Mr. Doug Henrichsen, Brown & Caldwell
Mr. Bruce Wagener, CNA

From: Kelton Barr, Braun Intertec

Subject: Hydrogeologic Analysis of Future Tunnel Vicinity
Minnehaha Park Area
Minneapolis, Minnesota

Project: B14-05975

Braun Intertec Corporation was retained by Brown and Caldwell to assist with several analyses involving the area of proposed construction of a sewer tunnel (tunnel) in the upper portion of the St. Peter Sandstone (St. Peter) in an area of Minnehaha Park in Minneapolis, Minnesota. These analyses had the following objectives:

- Compare the position and configuration of the tunnel with several hydrogeologic features previously identified in the Minnehaha Park area.
- Assess the likely pumping rates of proposed dewatering wells to be installed in the St. Peter and their effects on the interaction of the groundwater in the St. Peter aquifer and Minnehaha Creek.
-

This memorandum summarizes the analyses and their findings.

Methods

The position of the tunnel and associated structures were compared to several structural and karst features of the Platteville Formation that were identified in previous investigations in the vicinity (Liesch, 1973; Kelton Barr Consulting (KBC), 2000; Barr, 2009). These were compared to the locations of the tunnel, vault, and caissons, shown in Figure 1.

A groundwater flow model of the St. Peter aquifer was constructed using MLAEM version 5.2.00, the Multi-Layer Analytic Element Model written by Professor Otto D. L. Strack of the University of Minnesota. The model is a single-layer model of the St. Peter Aquifer; a nearby well log (see Appendix A) indicates a basal shale layer present as well as shaley layers within the general sandstone lithology of the unit. This would suggest that horizontal flow would predominate, allowing a single-aquifer representation of the St. Peter.

Area elements and line elements are included in the model representing the Minnehaha Creek below Minnehaha Falls and the nearby reaches of the Mississippi River and Minnesota River. Additional area elements and line elements represent net recharge to the aquifer in the general vicinity and buried bedrock valley recharge features in Minneapolis and St. Paul. The overall layout of all elements is shown in Figure 2, and a close-up of the elements in the Minnehaha Park vicinity is shown in Figure 3.

Initial input of the St. Peter aquifer characteristics were derived from the Metro Model 3 (Barr Engineering Co., 2014) and site data. These were calibrated against the January 24, 2014 water elevation data measured in monitoring wells B-2 and B-3 at the site; the final hydraulic characteristics are within the range for the metropolitan Twin Cities metropolitan area as denoted by Runkel *et al.* (2003). The interactions with surface water bodies – principally Minnehaha Creek below Minnehaha Falls and the Mississippi River and Minnesota River – were represented by areal and line elements. General net vertical leakage into the St. Peter is represented as an areal element. The proposed dewatering wells are represented by well elements. The elements in the model and their calibrated values are shown in the model input files in Appendix B.

Results

Near the base of the Magnolia Member of the Platteville Formation is a parting believed to be a solution-enlarged diastem (see Figure 4). This feature is commonly found throughout the Twin Cities metropolitan area and comprises nearly all of the horizontal transmissivity of the Platteville (Barr, 2009; Runkel *et al.*, 2011). This basal Magnolia parting is found along the sewer line of the project between 790.0 and 790.2 feet above mean sea level (feet msl), according to project borings (Figure 5). This would indicate that the two shafts would intersect this basal Magnolia parting; engineering measures will be needed to minimize the pumping rates during caisson construction without permanently plugging this parting for groundwater flow through the area. Localized plugging of the parting that extends only a few feet into the parting should allow groundwater flow to continue through the parting in this area and be acceptable. In addition the basal Magnolia parting is within a foot or so below the vault floor's base of 790.84 (Brown and Caldwell, 2014); the massive, blocky nature of the Magnolia would likely result in cracking of the remaining Magnolia during excavation to the floor elevation, yielding water to the excavation. .

Two hydraulically significant joints have been identified in Minnehaha Park (KBC, 2000), one trending approximately northwest-southeast and the other trending approximately northeast-southwest. Figure 6 shows the general locations of these joints; the two northwest-southeast trends are from the results of the pumping test in Liesch (1973) for the dashed line, and from the results of the 1999 pumping test described in KBC (2000) for the solid lines. Results from the pumping test in Liesch (1973) found that wells near these joints had anomalously high apparent transmissivities. KBC (2000) reported that an excavation into the Platteville near the dashed-line joint resulted in ongoing dewatering of the excavation for several months of approximately 500 gallons per minute (see Figures 7 and 8). The source of this water was the basal Magnolia parting on the east excavation wall, the side nearest to the inferred location of the northwest-southeast trending joint. This northwest-southeast trending joint crosses the sewer line at approximately 8+850 as indicated on Figure 9. It should be noted that the identification of the two northwest-southeast trending joints indicates that the joints may consist of several *en eschelon* joints so that hydraulically significant joints may be encountered in the vicinity of the locations indicated. It is unknown how hydraulically continuous this joint is across formation boundaries; however, joints have been observed extending from the Platteville and through the St. Peter along the Minnehaha Creek bluffs (KBC, 2000).

Of greater concern is at the vault floor. The possibility that any induced cracking of the remaining Magnolia, along with the basal Magnolia parting, the proximity of the northwest-southeast trending joint (described below), and even the proximity of Minnehaha Creek could potentially hydraulically connect to deliver large flow rates to the excavation. Efforts to minimize the pumping rates must avoid plugging flow through the basal Magnolia and the joint in the area; this joint is likely a major source of water discharging at Camp Coldwater Spring to the southeast, a spring of historical and Native American spiritual importance (Barr, 2009). Localized plugging of the parting and encountered joints so that the plugging extends only a few feet into the partings should allow groundwater flow to continue through the parting in this area and be acceptable.

The calibrated potentiometric surface of the St. Peter Aquifer on January 24, 2014 in the Minnehaha Park vicinity is shown in Figure 10. As can be seen, groundwater flow in the St. Peter is simulated to be easterly to southeasterly with some discharge to Minnehaha Creek below the falls and to the Mississippi River. Discharge to the Mississippi is influenced by Lock and Dam No. 1 immediately east of Minnehaha Falls.

To effectively dewater the St. Peter to groundwater elevations below 750, several dewatering wells were placed in the model. Figures 11 and 12 show the potentiometric surface resulting from two wells installed at the western and middle locations shown on Drawing CU1 (Appendix C). These wells are called W-1 and W-2, respectively, in this report. The wells are represented in the model as fully-penetrating wells with drawdowns in the wells to Elevation 740 feet mean sea level (msl); this results in water levels slightly less than 750 feet msl in the eastern portion of the tunnel and slightly higher than 750 feet msl in the western portion of the tunnel. The long-term (*i.e.* steady-state) combined discharge rates of these two wells was estimated to be 235 gallons per minute (gpm). A transient calculation of pumping rates of Wells W-1 and W-2 using the Jacob equation is summarized in Figure 13. This indicates an initial, combined pumping rate of over 500 gpm, dropping to a pumping rate between 200 and 300 gpm after two years. This calculation assumed unconfined conditions and the calibrated transmissivity from the groundwater model. It also assumes that the Glenwood effectively seals off leakage through joints into the St. Peter, as is generally observed in tunnels along the upper surface of the St. Peter in other parts of the Twin Cities (Bruce D. Wagener, personal communication; October, 2014).

Figures 14 and 15 show the potentiometric surface resulting from three wells installed at the western, middle, and eastern locations shown on Drawing CU1 (Appendix C). These wells are called W-1, W-2, and W-3, respectively, in this report. Model results indicate that the long-term, combined discharge rates of these three wells are approximately 270 gpm. As can be seen, the addition of a third well does not appreciably increase the dewatering rates for the tunnel construction.

The model was also used to assess the effects of the dewatering wells on the groundwater discharge to Minnehaha Creek and Mississippi River. This was done by using the CHECK function to determine the discharge rates calculated for the head-specified areal elements (ARELs) representing discrete reaches of these surface water features. These discharge rates were the result of the difference in the specified surface water elevation and the model-calculated groundwater elevations of the underlying St. Peter aquifer and the specified hydraulic resistance of the streambed. Positive values of the calculated AREL discharges indicate upward flow, *i.e.* groundwater discharge to the surface water bodies; negative values indicate groundwater recharge by the surface water bodies.

The discharge rates for the ambient (non-pumping) conditions and for the conditions prevailing when the dewatering wells are operating are summarized in Table 2. The discharge rates for the areal elements of the Minnehaha Creek and the nearby reaches of the Mississippi River are listed individually for both conditions. The total groundwater discharge rate of these ARELs during ambient conditions is estimated to be 813,000 cubic feet per second (cfd) (4,220 gpm); the total groundwater discharge rate of these ARELs during pumping conditions is estimated to be 784,000 cfd (4,070 gpm), a decrease of 29,400 cfd (151 gpm). This is a 3.6 percent (%) decrease in groundwater discharge to these surface water bodies. By comparison, the modeled discharge rates of the dewatering wells are a total of 45,300 cfd (235 gpm). The decrease in groundwater discharge to these surface water bodies comprises approximately 64% of the dewatering rates. The remainder of the dewatering pumpage is St. Peter groundwater that ultimately discharges to other reaches of the Mississippi and the Minnesota River. It should be noted that the dewatering pumpage will be discharged through direct discharge or through the existing storm sewers of the area to the Mississippi.

General Remarks

The analyses and conclusions submitted in this report are based on our project information provided by others and publicly available information. In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, expressed or implied, is made.

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Runkel, Anthony C., Julia R. Steenberg, and Robert G. Tipping, *Hydraulic Conductivity and Hydrostratigraphy of the Platteville Formation*, Twin Cities Metropolitan Area, Minnesota: Minnesota Geological Survey report to Metropolitan Council, 2011.

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FIGURES

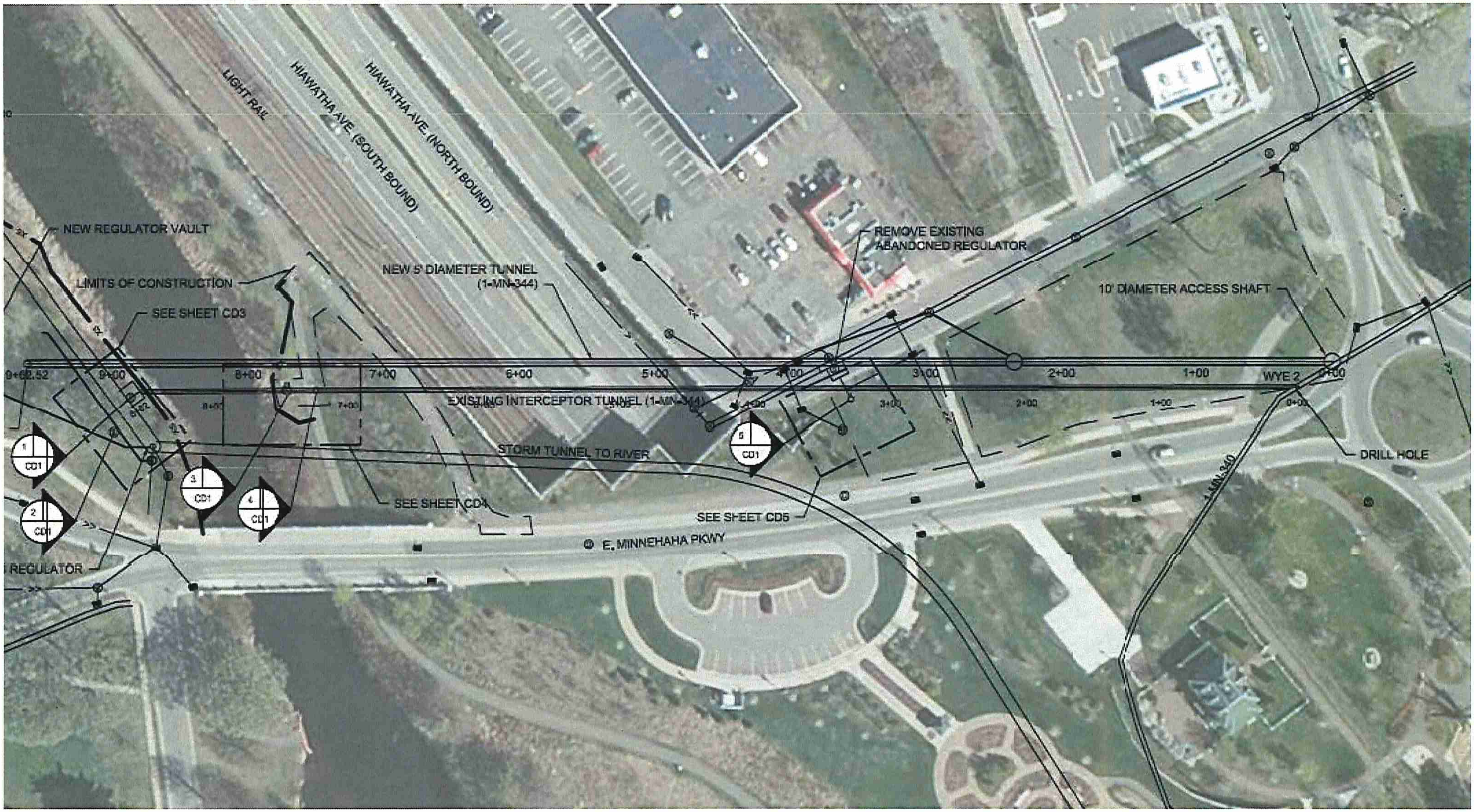


Figure 1. Location of the sewer, vault, and shafts (base map from Brown & Caldwell)

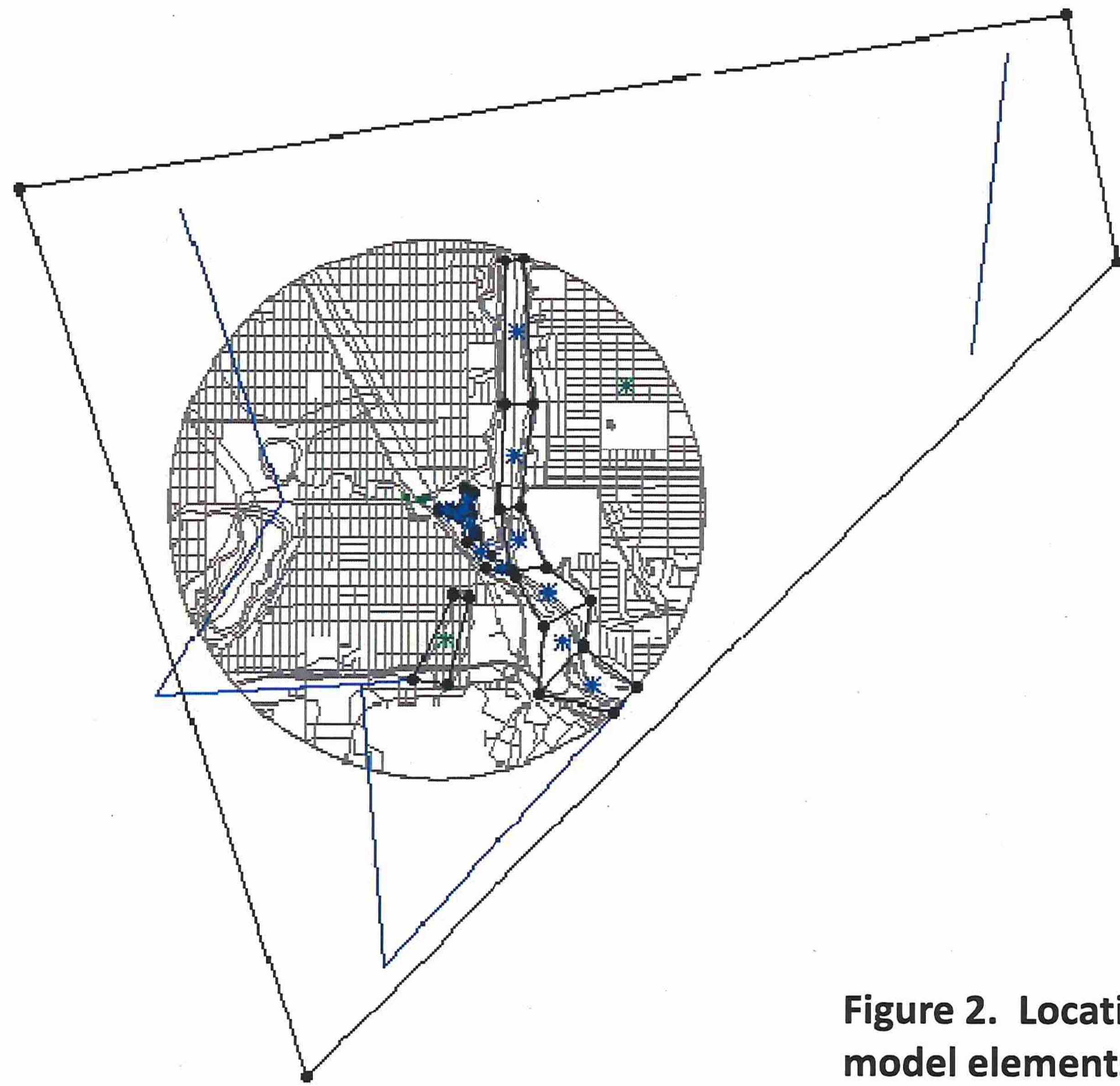


Figure 2. Location of MLAEM model elements

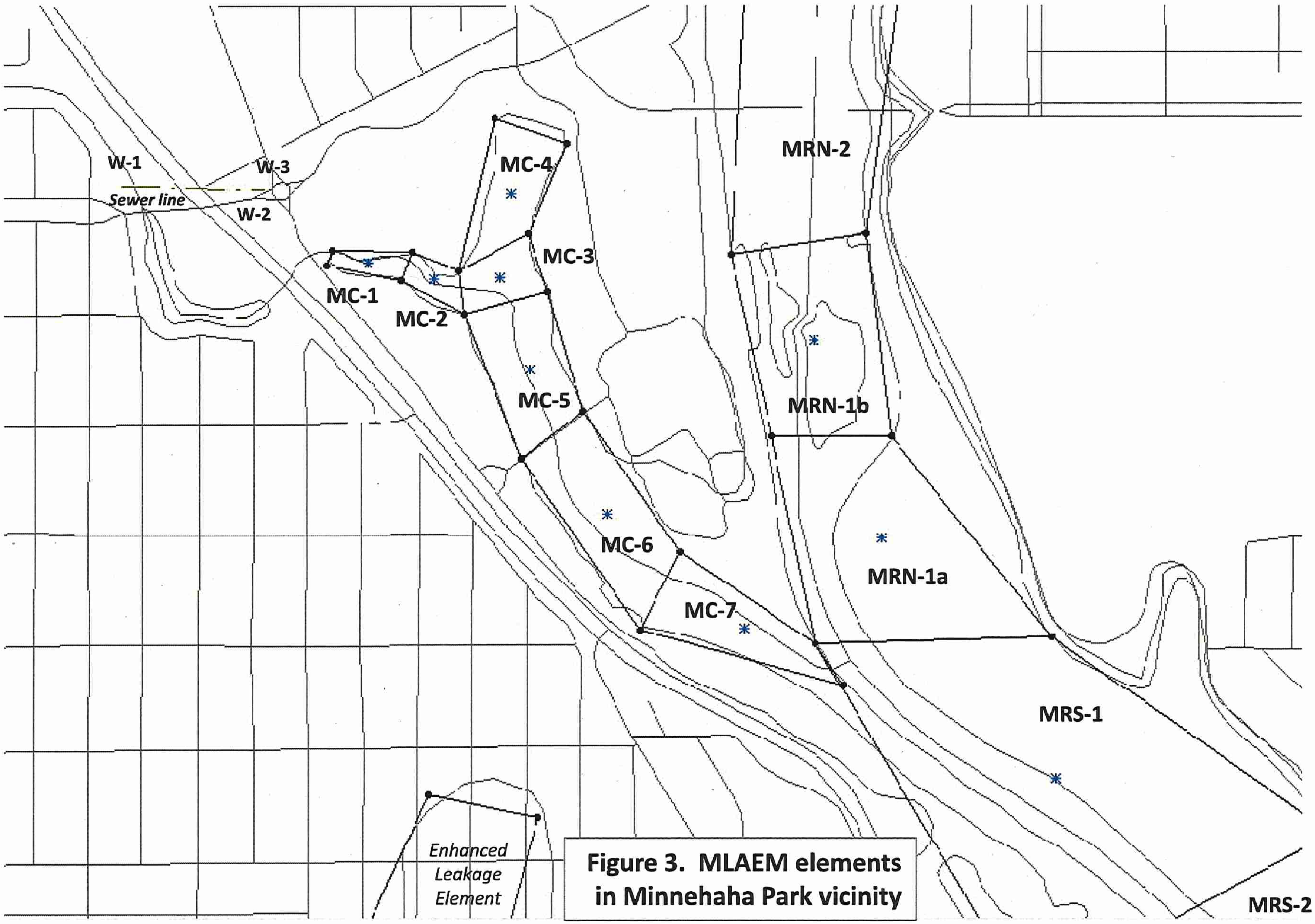


Figure 3. MLAEM elements in Minnehaha Park vicinity

Figure 4. Basal Magnolia solution zone in outcrop near Minnehaha Falls in downstream gorge.

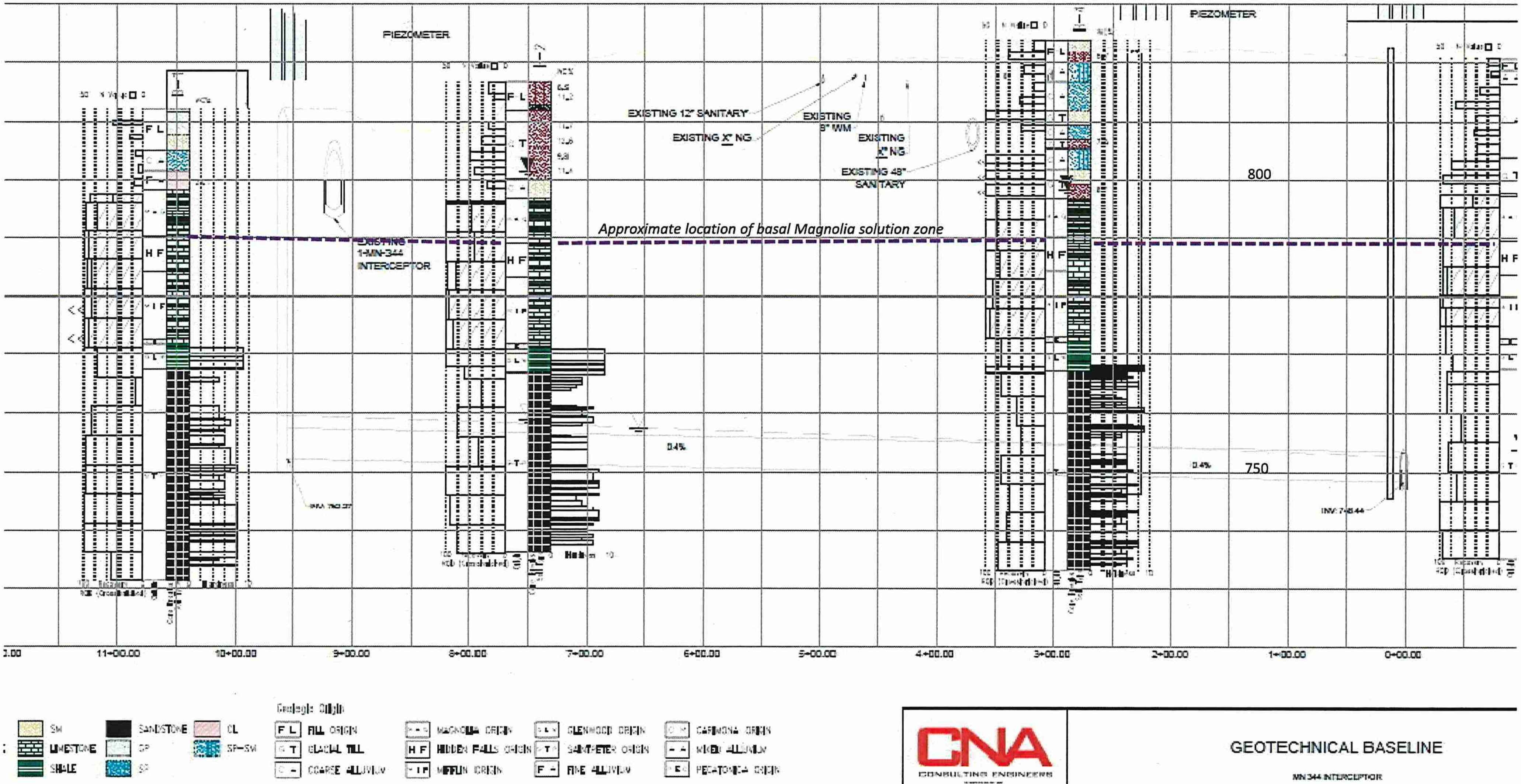


Figure 5. Location of basal Magnolia solution zone in tunnel vicinit (base map from CNA, 2014

Figure 6. Locations of joint trends identified in Minnehaha Park vicinity (base map from Brown and Calwell)

Figure 7. Groundwater entering excavation via basal Magnolia parting (photo by K. Barr)

Figure 8. Water entering east face of excavation at approx. 500 gpm (photo by K. Barr)

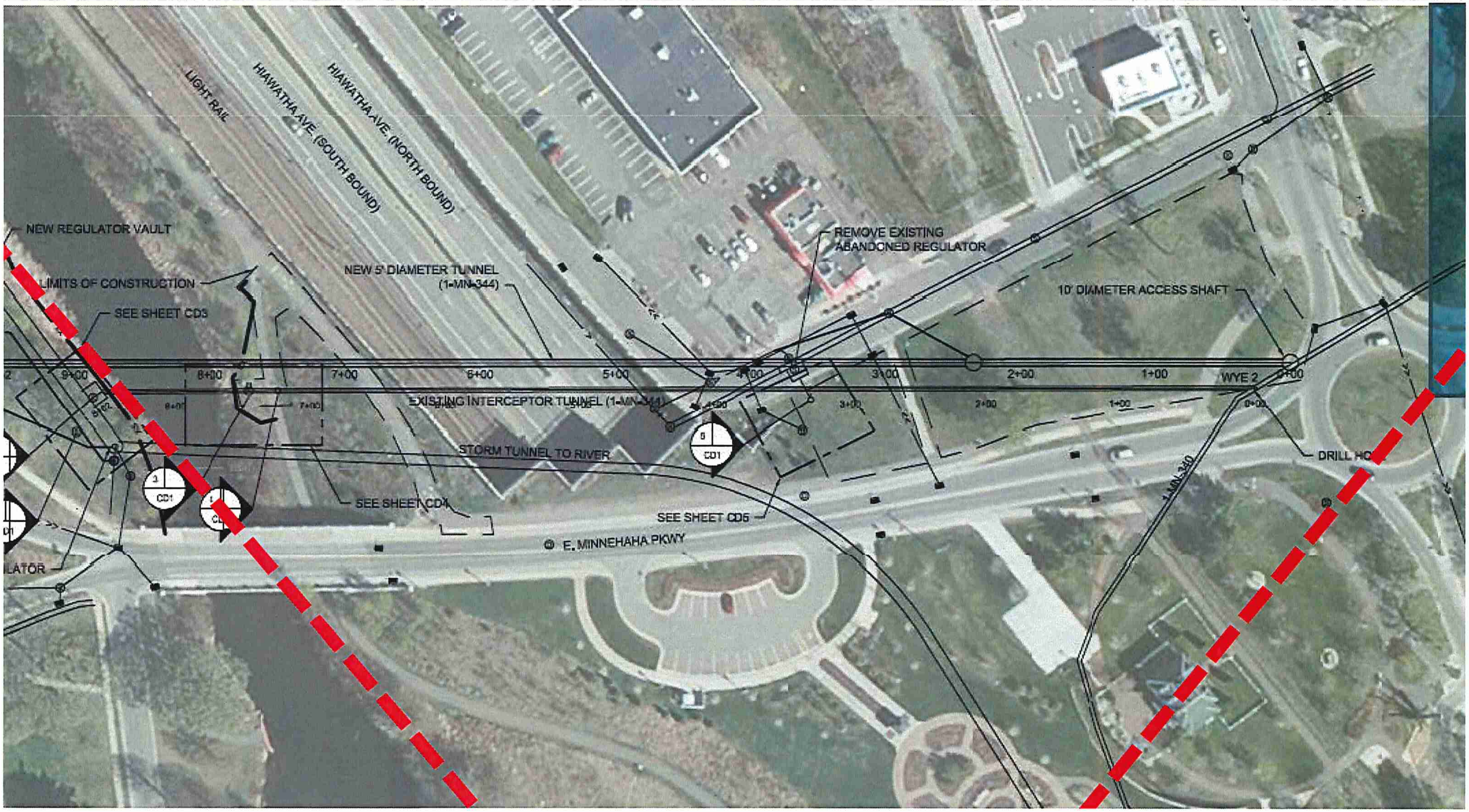


Figure 9. Location of hydraulically prominent joints, compared to the location of the tunnel features (base map from Brown & Caldwell)

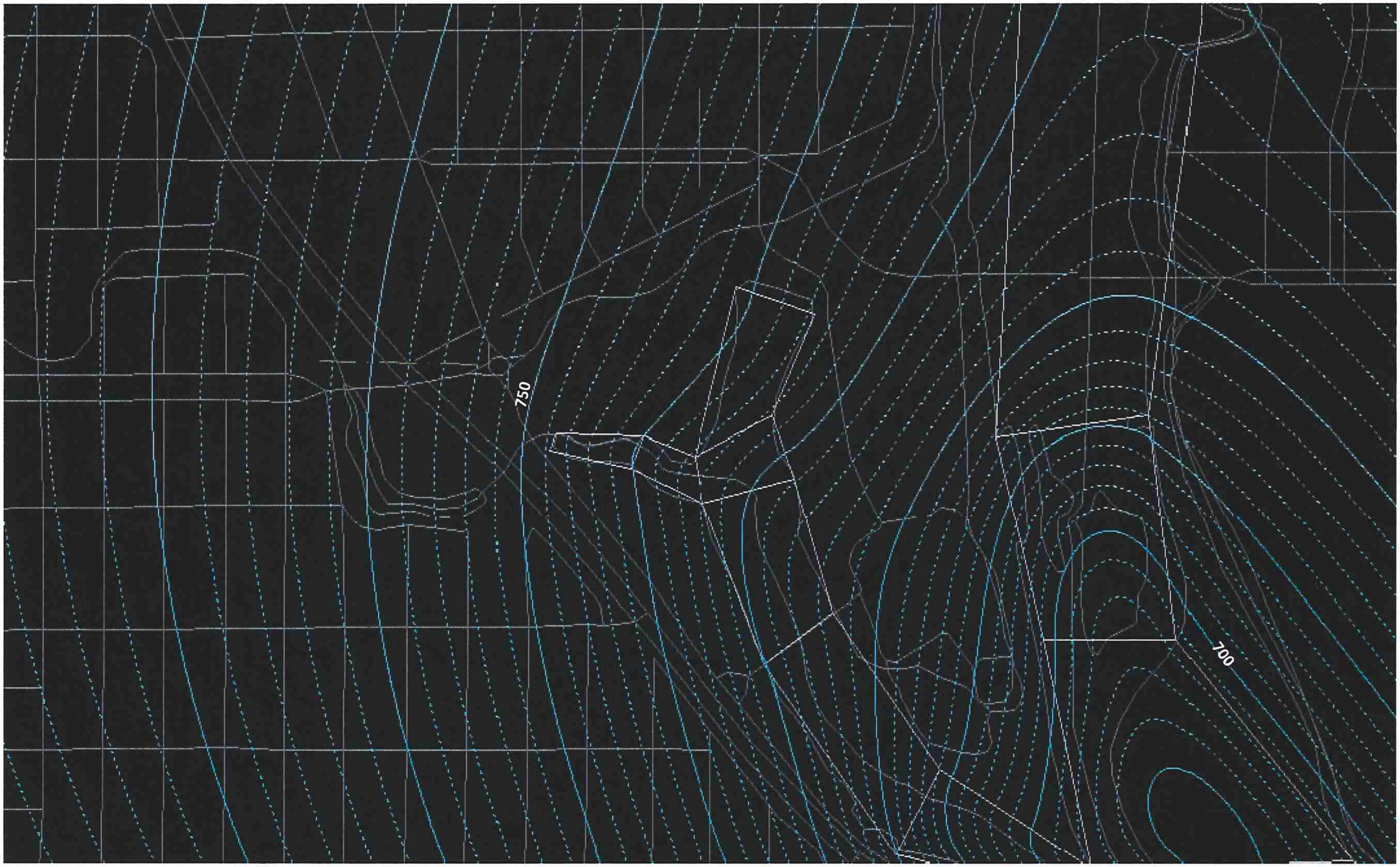


Figure 10. St. Peter potentiometric surface (1/24/2014) – ambient conditions

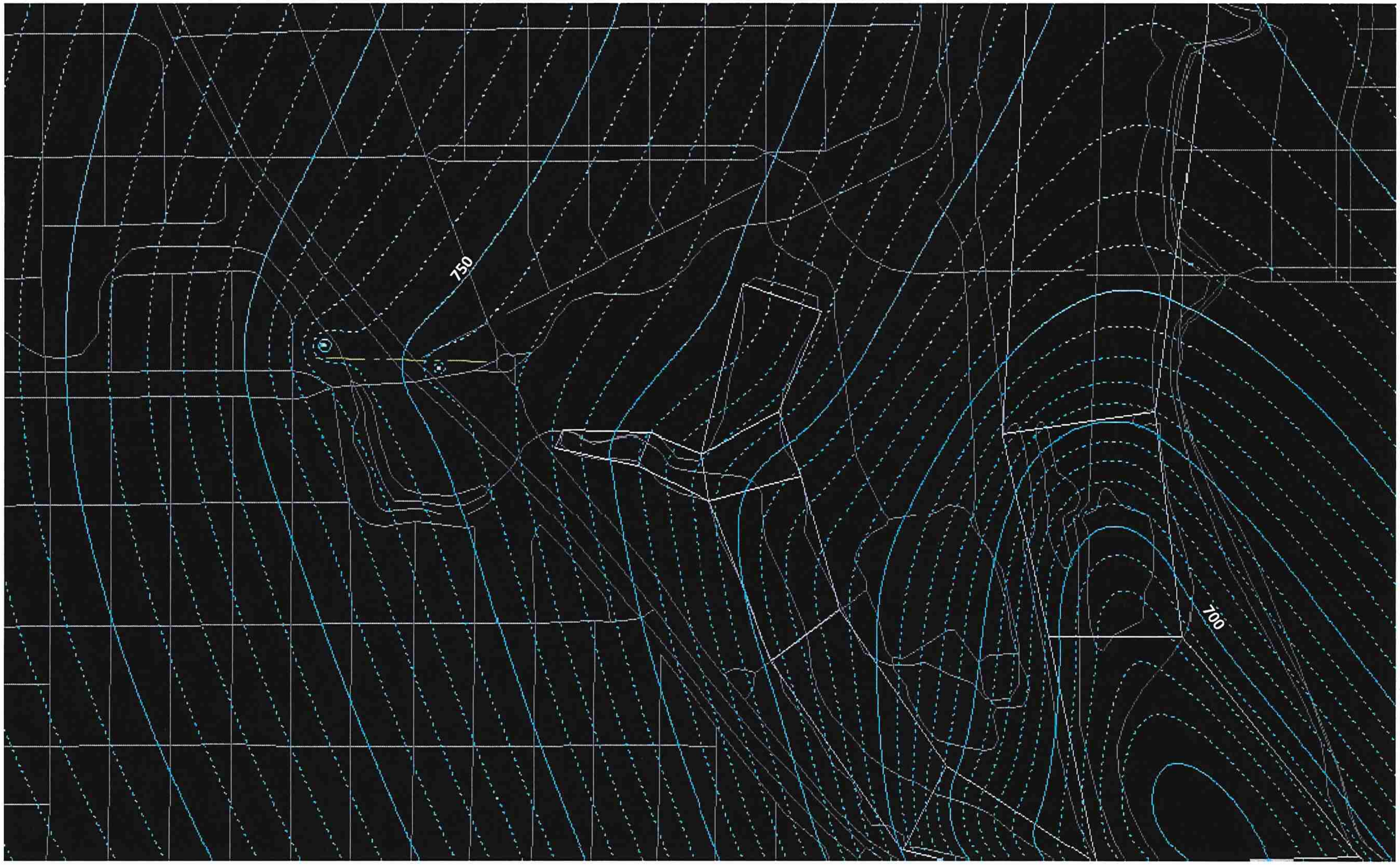


Figure 11. St. Peter potentiometric surface – 2 dewatering wells (CI=2 ft)

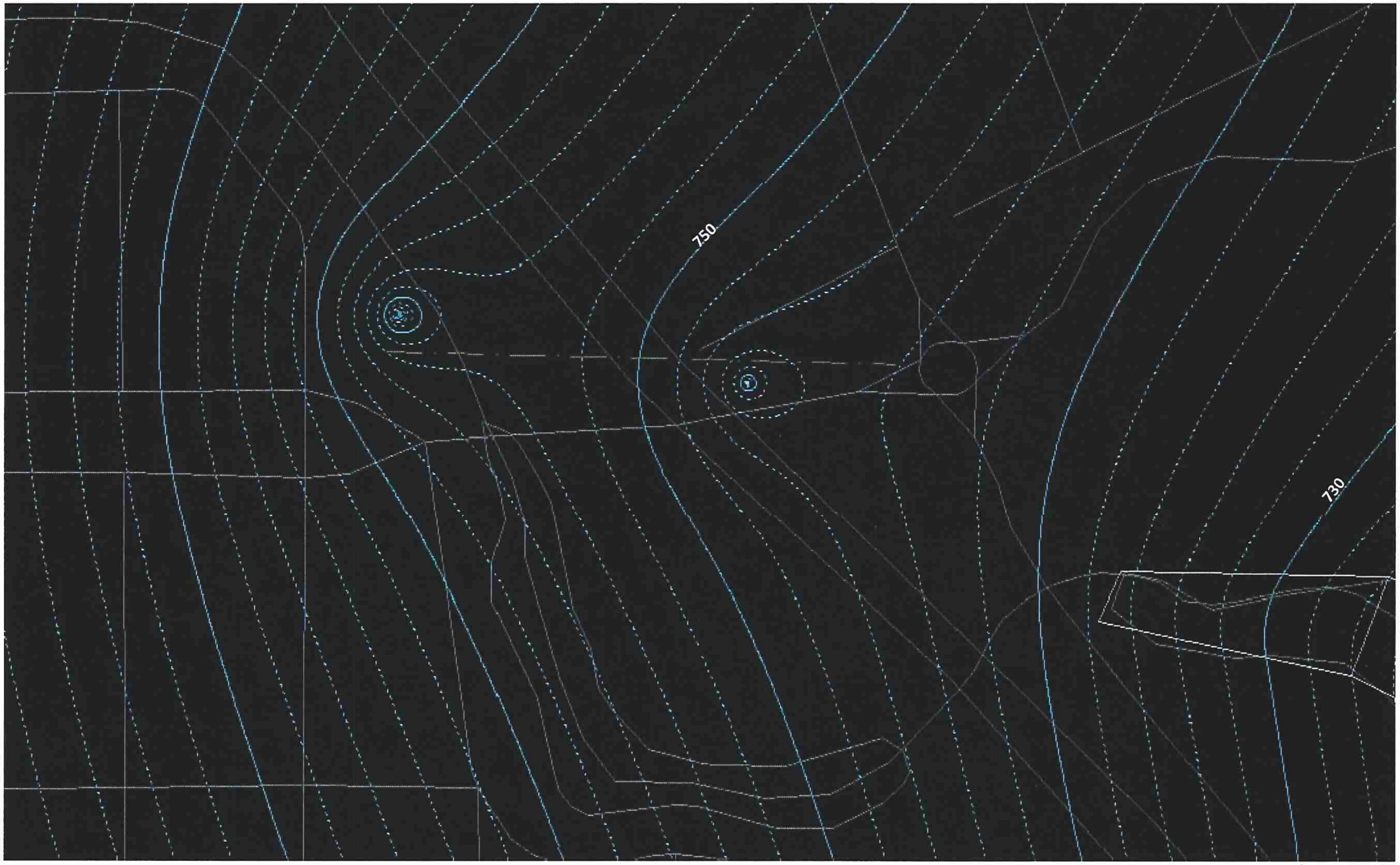
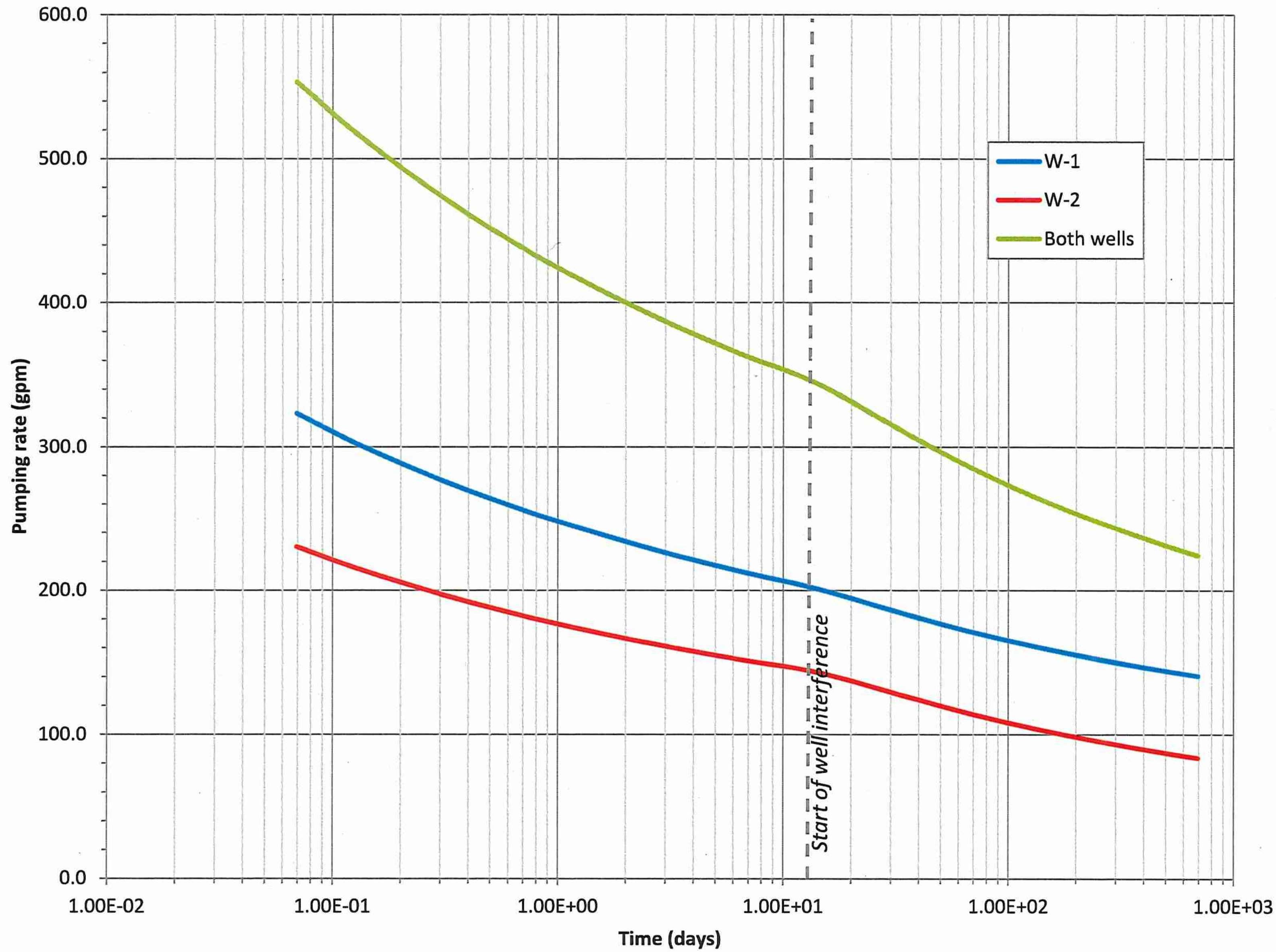


Figure 12. St. Peter potentiometric surface – 2 dewatering wells (close-up) (CI=2 ft)

Figure 13.   2 St. Peter Wells (W-1 and W-2) - Pumping Rate vs Time



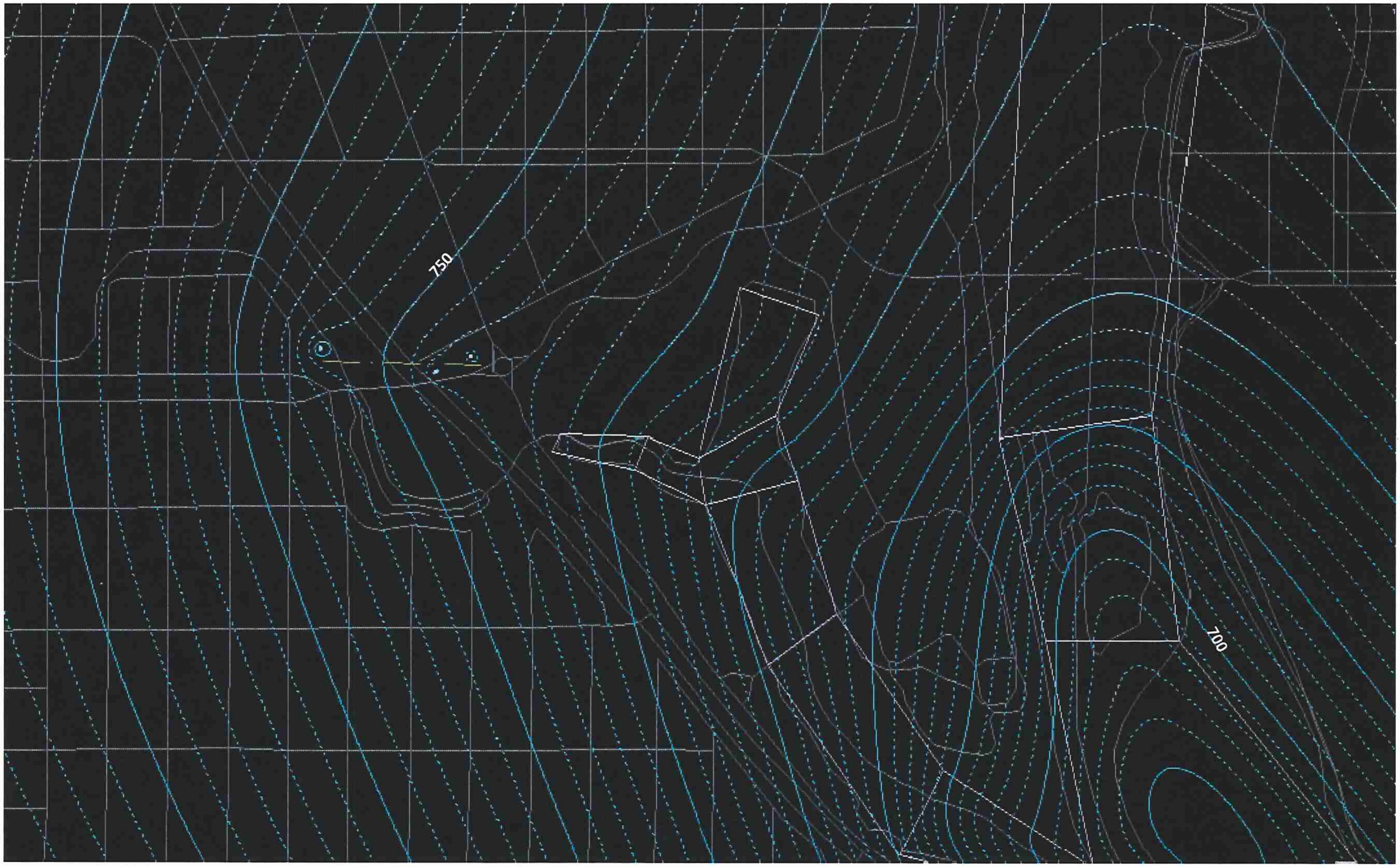


Figure 14. St. Peter potentiometric surface – 3 dewatering wells (CI=2 ft)

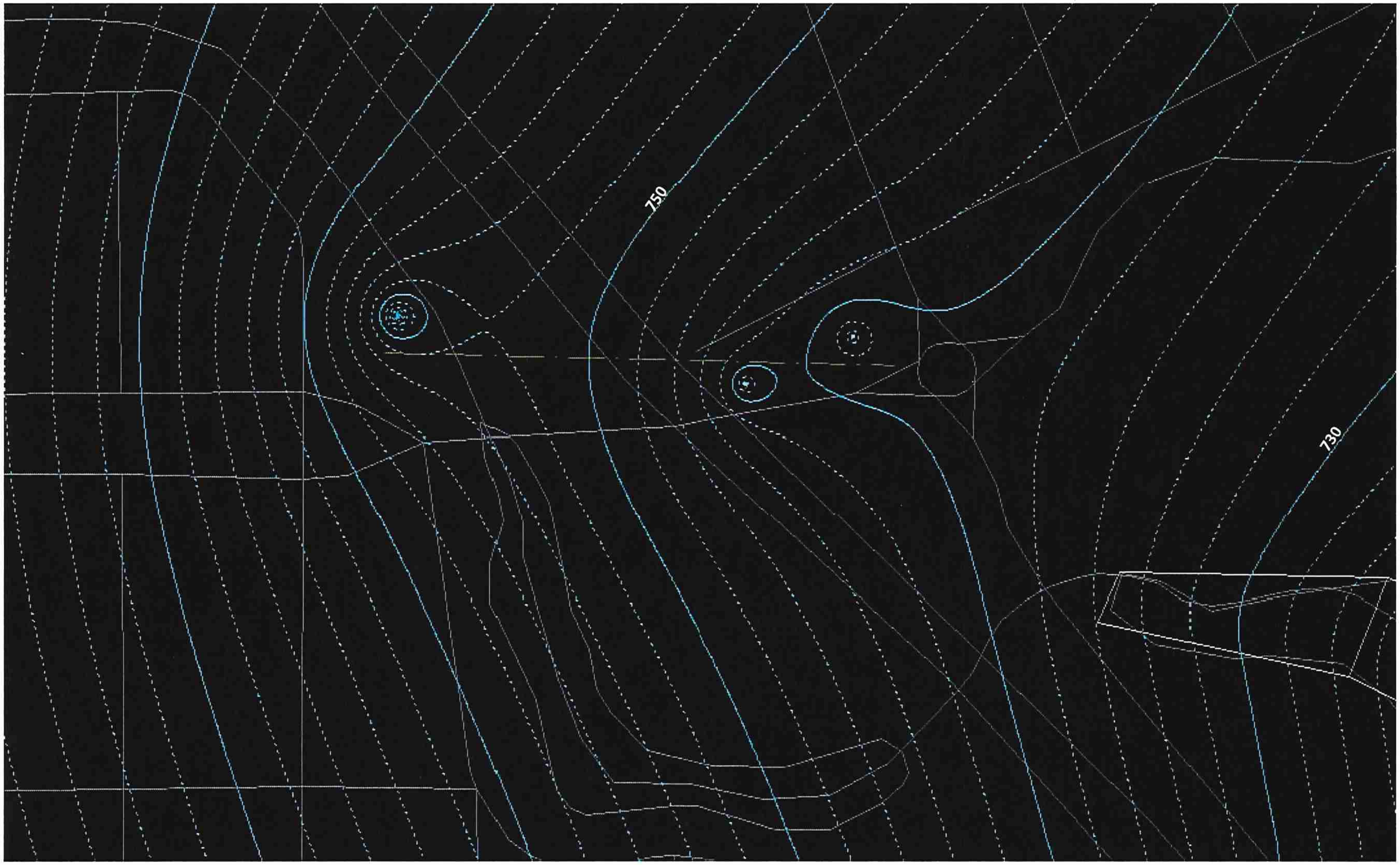


Figure 15. St. Peter potentiometric surface – 3 dewatering wells (close-up) (CI=2 ft)

TABLES

Table 1. COEFFICIENTS OF TRANSMISSIBILITY AND STORAGE

Minnehaha Park near Highway 55

Pumping rate (gpm)	Well No.	Test duration (hours)	Maximum drawdown (feet)	T (gpd/ft)	S	Coefficients calculated from:
90	T1d-wa	48	17.5	40,000		recovery in pumping well
90	T1d-wa	48	17.5	36,554	2.6E-03	time-drawdown curve at T1f-Pa (6")
90	T1d-wa	48	17.5	530,000	8.8E-03	distance-drawdown curve from T9-wa to T10-wa
8	T2d-wa	2	4.5	1,400		time-drawdown curve at pumping well
8	T2d-wa	2	4.5	3,840	4.0E-05	time-drawdown curve at T2b-Pa (6")
8	T2d-wa	2	4.5	5,000	1.2E-04	distance-drawdown curve
30	T3d-wa	24	7.5	5,200	4.2E-05	time-drawdown curve atT3b-Pa (6")
8	T4b-Pa (6")	1	4.9	4,000	4.0E-03	time-drawdown curve at T4d-wa
8	T4d-wa	1	1.9	4,200	4.0E-03	time-drawdown curve at T4b-Pa(6")
8	T5b-Pa(6")	1.5	0.5	7,000	1.8E-05	time-drawdown at T4b-Pa(6")
8	T6-wa	1	2.9	5,700		time-drawdown curve at pumping well
10	T7-wa	1.25	3.7	2,900		time-drawdown curve at pumping well
60	T9-wa	2	0.14	700,000		time-drawdown curve at pumping well
60	T10-wa	1	0.07	1,600,000	9.0E-03	distance-drawdown curve at observation wells
10	T2d-Wb	3	2.73	6,800	1.6E-01	drawdown at T2C-Pb
30	T4b-Wb	1	2.15	17,600	5.8E-02	drawdown at pumping well T4b-Wb
30	T4b-Wb	1	2.15	26,000		
			Average =	176,247	2.2E-02	
			median =	6,800	4.0E-03	
			mean =	16,881	1.5E-03	

(from Bruce A. Liesch, 1973, *Groundwater Investigation for Minnesota Highway Department at Minnehaha Park Tunne* l, Table 2)

Table 2. Effects of dewatering wells on groundwater discharge to Minnehaha Creek and Mississippi River

AREL No.	AREL Name	AREL Discharge Rates[1] (cfd)		Change in Discharge Rates (cfd)	Percent Change
		Ambient (no pumping)	Pumping (W-1 & W-2)		
1	MC-1	1.08E+04	7.18E+03	-3.59E+03	-33.3%
2	MC-2	1.04E+04	8.19E+03	-2.23E+03	-21.4%
3	MC-3	1.17E+04	9.61E+03	-2.13E+03	-18.1%
4	MC-4	-1.49E+04	-2.01E+04	-5.23E+03	35.2%
5	MC-5	2.57E+04	2.31E+04	-2.58E+03	-10.0%
6	MC-6	8.91E+03	6.79E+03	-2.12E+03	-23.8%
7	MC-7	4.51E+04	4.43E+04	-8.51E+02	-1.9%
8	MRN-1a	4.75E+04	4.69E+04	-5.88E+02	-1.2%
9	MRN-1b	6.11E+04	6.04E+04	-7.01E+02	-1.1%
10	MRN-2	6.20E+04	5.70E+04	-5.05E+03	-8.1%
11	MRN-3	3.29E+05	3.27E+05	-2.79E+03	-0.8%
12	MRS-1	8.82E+04	8.76E+04	-5.80E+02	-0.7%
13	MRS-2	8.73E+04	8.68E+04	-4.73E+02	-0.5%
14	MRS-3	3.94E+04	3.94E+04	-7.10E+01	-0.2%
Sum of AREL discharge rates (cfd)		**8.13E+05**	**7.84E+05**	**-2.90E+04**	**-3.6%**
Sum of AREL discharge rates (gpm)		**4.22E+03**	**4.07E+03**	**-1.51E+02**	

Well No.	Well Name	Well Discharge Rate (cfd)
1	W-1	2.83E+04
2	W-2	1.70E+04
Sum of WELL discharge rates (cfd)		**4.53E+04**
Sum of WELL discharge rates (gpm)		**2.35E+02**

[1]Positive discharge rates indicate discharge of groundwater to surface water feature

APPENDICES

APPENDIX A

Well log 236024

Minnesota Unique Well No.

236024

County Hennepin
Quad St Paul West
Quad ID 103B

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/24/1991
Update Date 03/10/2014
Received Date

Well Name TIRO INDUSTRIES, INC.

Township	Range	Dir	Section	Subsections	Elevation
28	23	W	7	CACACA	832 ft.

Elevation Method 7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
364 ft.	364 ft.	05/21/1970

Drilling Method Cable Tool

Well Address
3612 44TH ST E
MINNEAPOLIS MN

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Industrial

Casing Type Steel (black or low carbon) **Joint** No Information **Drive Shoe?** ☐ Yes ☐ No **Above/Below** 0 ft.

Geological Material	Color	Hardness	From	To
FILL CINDERS & GRAVEL			0	2
CLAY	YELLOW		2	7
SAND-SILTY			7	23
CLAY	BLUE		23	28
SAND & GRAVEL			28	45
SAND, GRAVEL, SHALE & BROKEN LR.			45	58
PLATTEVILLE LIMEROCK			58	76
ST. PETER SANDROCK SHALEY			76	126
ST. PETER SANDROCK			126	188
ST. PETER SANDROCK SHALEY			188	195
SHALE	BLUE		195	208
ST. PETER SANDROCK SHALEY			208	240
SHAKOPEE LIMEROCK			240	364

Casing Diameter	Weight	Hole Diameter
16 in. to 57 ft.	lbs./ft.	
12 in. to 253 ft.	lbs./ft.	

Open Hole from 253 ft. to 364 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
42 ft. from Land surface Date Measured 05/21/1970

PUMPING LEVEL (below land surface)
126 ft. after hrs. pumping 500 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
FORMERLY 7-UP BOTTLING CO. OLD P.A. 70-0070.
CREVICES 259, 294, 297, 301, 310, 312, 324, 334.

Grouting Information Well Grouted? ☐ Yes ☐ No ☐ Not Specified

Located by: Minnesota Geological Survey
Method: Digitization (Screen) - Map (1:24,000)
Unique Number Verification: N/A
Input Date: 08/17/2004
System: *UTM - Nad83, Zone15, Meters*
X: 482622 **Y:** 4974598

Nearest Known Source of Contamination
_feet _direction _type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number__ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)?
☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock Platteville Formation
Last Strat Prairie Du Chien Group
Aquifer Prairie Du Chien Group
Depth to Bedrock 58 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Bergerson-Caswell	27058	

APPENDIX B

MLAEM input files

```
*                  Appendix B-1.  MLAEM model input file -- AMBIENT CONDITIONS
*
*
*
*Minnehaha Park Tunnel Improvements, Minneapolis, MN -- St. Peter Dewatering
*
***************************************************************************************
*
* Braun Intertec Project No. B14-05975
*
***************************************************************************************
*
***************************************************************************************
*
*
*
***************************************************************************************
*
*
return
window 537928 141089 554020 149738
aquifer
layer 1
global
base 670 * feet above msl
perm 25 * feet per day ( = 2.47E-02 cm/sec)
thick 100 * feet
por 0.25
ret
reference
layer 1
  544700 163800 850
return
map
  curve
    543050 145820
    543986 145798
  plot on
 ret
arel
 layer 1
  top
   given
     527900 158000 539300 123100 571100 155200 569000 164900 -2.835e-6 *leakage thru
Og
     543387 138679 544714 138457 545632 141999 544968 142125 -2.83465e-3 *leakage
via near-south BR valley
 ret
arel
 layer 1
  top
   resis
     544349 145335 544388 145423 544868 145413 544799 145237 50 735 *MC-1
     544868 145413 544799 145237 545191 145041 545152 145296 50 730 *MC-2
     545191 145041 545152 145296 545573 145521 545690 145178 50 728 *MC-3
     545573 145521 545152 145296 545372 146223 545802 146076 50 740 *MC-4
     545690 145178 545191 145041 545528 144161 545903 144445 115 720 *MC-5
     545903 144445 545528 144161 546251 143126 546490 143593 120 720 *MC-6
     546251 143126 546490 143593 547314 143043 547479 142796 130 687 *MC-7
     547314 143043 548741 143088 547774 144295 547050 144295 100 687 *MRN-1a
     546794 145401 547622 145523 547774 144295 547050 144295 200 687 *MRN-1b
     546794 145401 547622 145523 548165 149585 547025 149559 200 725 *MRN-2
     548165 149585 547025 149559 547051 155244 547725 155269 200 725 *MRN-3
     548741 143088 547314 143043 548589 140886 550438 141895 100 687 *MRS-1
```

```
     548589 140886 550438 141895 550096 139976 548390 138085 150 687 *MRS-2
     550096 139976 548390 138085 551362 137473 552301 138440 150 687 *MRS-3
 ret
arel
 draw on top
 ret
*well
*  head
*    90 177 1030 0.25
*    123 63 1030 0.25
*    0 114 1030 0.25
* ret
line
  head
    534222 157217 538254 145707 810 [West-1] *BR valley W of site-1
    538254 145707 533344 138051 810 [West-2] *BR valley W of site-2
    533344 138051 541349 138460 810 [West-3] *BR valley W of site-3
    541349 138460 542266 127410 810 [West-4] *BR valley W of site-4
    542266 127410 552301 138440 720 [South-1] *BR valley S of site-5
    565290 151490 566750 163430 755 [East-1] *BR valley-SW St. Paul-6
    541349 138460 543387 138679 810 [West-5] *BR valley near-S of site-7
 ret
solve
solve
solve
solve
grid 500
che
  head 543428 146081 759.15 * B-2 (1/24/2014)
  head 543921 145868 753.20 * B-3 (1/24/2014)
 ret
switch
end
```

```
*              Appendix B-2 - MLAEM input file - pumping conditions
*
*
*
*Minnehaha Park Tunnel Improvements, Minneapolis, MN -- St. Peter Dewatering
*
********************************************************************************
*
* Braun Intertec Project No. B14-05975
*
********************************************************************************
*
********************************************************************************
*
*
*
********************************************************************************
*
*
return
window 540872 143058 550173 147769
aquifer
layer 1
global
base 670 * feet above msl
perm 25 * feet per day ( = 2.47E-02 cm/sec)
thick 100 * feet
por 0.25
ret
reference
layer 1
  544700 163800 850
return
map
  curve
    543050 145820
    543986 145798
  plot on
 ret
arel
 layer 1
  top
   given
     527900 158000 539300 123100 571100 155200 569000 164900 -2.835e-6 *leakage thru
Og
     543387 138679 544714 138457 545632 141999 544968 142125 -2.83465e-3 *leakage
via near-south BR valley
 ret
arel
 layer 1
  top
   resis
     544349 145335 544388 145423 544868 145413 544799 145237 50 735 *MC-1
     544868 145413 544799 145237 545191 145041 545152 145296 50 730 *MC-2
     545191 145041 545152 145296 545573 145521 545690 145178 50 728 *MC-3
     545573 145521 545152 145296 545372 146223 545802 146076 50 740 *MC-4
     545690 145178 545191 145041 545528 144161 545903 144445 115 720 *MC-5
     545903 144445 545528 144161 546251 143126 546490 143593 120 720 *MC-6
     546251 143126 546490 143593 547314 143043 547479 142796 130 687 *MC-7
     547314 143043 548741 143088 547774 144295 547050 144295 100 687 *MRN-1a
     546794 145401 547622 145523 547774 144295 547050 144295 200 687 *MRN-1b
     546794 145401 547622 145523 548165 149585 547025 149559 200 725 *MRN-2
     548165 149585 547025 149559 547051 155244 547725 155269 200 725 *MRN-3
     548741 143088 547314 143043 548589 140886 550438 141895 100 687 *MRS-1
```

```
     548589 140886 550438 141895 550096 139976 548390 138085 150 687 *MRS-2
     550096 139976 548390 138085 551362 137473 552301 138440 150 687 *MRS-3
 ret
arel
 draw on top
 ret
well
  head
    543091 145887 740 .5 [W-1]
    543717 145764 740 .5 [W-2]
*    543909 145850 740 .5 [W-3]
 ret
line
  head
    534222 157217 538254 145707 810 [West-1] *BR valley W of site-1
    538254 145707 533344 138051 810 [West-2] *BR valley W of site-2
    533344 138051 541349 138460 810 [West-3] *BR valley W of site-3
    541349 138460 542266 127410 810 [West-4] *BR valley W of site-4
    542266 127410 552301 138440 720 [South-1] *BR valley S of site-5
    565290 151490 566750 163430 755 [East-1] *BR valley-SW St. Paul-6
    541349 138460 543387 138679 810 [West-5] *BR valley near-S of site-7
 ret
solve
solve
solve
solve
grid 500
che
  head 543428 146081 759.15 * B-2 (1/24/2014)
  head 543921 145868 753.20 * B-3 (1/24/2014)
 ret
switch
end
```

Figure 7. Groundwater entering excavation via basal Magnolia parting (photo by K. Barr)

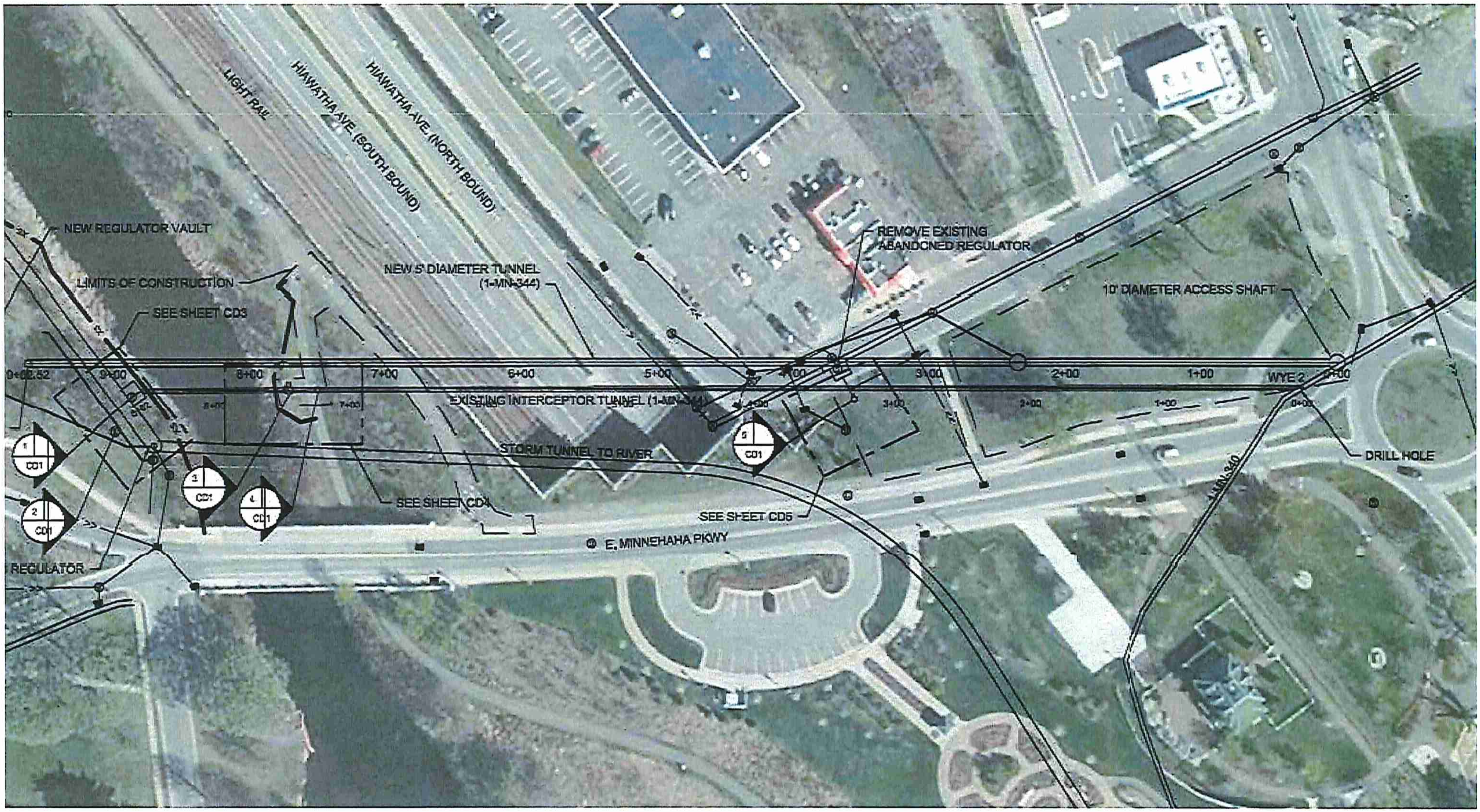


Figure 1. Location of the sewer, vault, and shafts (base map from Brown & Caldwell)