Interstate 494 Improvements

Penn Avenue to the Minnesota River: Interstate 494 Stormwater Alternatives Study

Minnesota Department of Transportation
Metro District

Final
31 May 2007

Stanley Consultants INC.
A Stanley Group Company
Engineering, Environmental and Construction Services - Worldwide

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31 May 2007

I hereby certify that this plan, specification, or report was prepared by me or under my direct personal supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

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Executive Summary

The purpose of this study is to assist the Minnesota Department of Transportation (Mn/DOT) in determining the best means for stormwater drainage of I-494 from Penn Avenue to the Minnesota River (and potentially to the west of Penn Avenue to TH169) by expanding upon the I-494 Tunnel Feasibility Study (TFS), dated February 2002, and the I-494 Drainage Feasibility Study (DFS) of June 2005. The TFS, while limited in scope, indicated that a stormwater tunnel was the best means of addressing the drainage system for future I-494. The DFS showed that there was a possibility for reuse of the existing storm sewer, and that this reuse could result in significant project savings. This study provides additional investigation to answer particular concerns raised by Mn/DOT after the DFS was submitted.

I-494 is one of the most heavily traveled roadways in Minnesota. Approximately 178,000 vehicles per day currently travel in the corridor (2002), with an expected increase to 225,000 vehicles per day by the year 2022. Any interruption to the highway system is significant to the traveling public and commerce along the corridor. The storm sewer that serves the corridor does not meet current Mn/DOT standards as it surcharges at roadway low points in storms approximating the five-year event.

The increase in impervious surface from the proposed expansion of I-494, combined with the inadequacies of the existing drainage system precipitates the need for drainage system improvements. To meet design criteria, the proposed drainage system must be sized to convey 80 percent greater storm flows than under current conditions and do so without flooding or surcharging. Maintaining the existing system as the primary drainage conduit for I-494 would increase the incidence of flooding along the highway and expose the users to an unacceptably high level of risk.

The intent of this report is to explore in more detail the previous preferred Alternatives based on concerns raised by Mn/DOT during their internal review of the previous studies. Stanley Consultants led a team including Wenck Associates, in the development of this study. The

approach included in-depth alternative analysis of the six preferred options from the previous two studies (Alt. 1C, 2C, 2D, 2E, 4A and 5A), municipal and agency involvement, corridor hydrology, hydraulics, water quality, subsurface investigation, and the development of suitable exhibits for presentation and for this report. During the alternative analysis, one additional potential drainage alternative was identified, Alt. 2F. Municipal and agency involvement, meetings were held with the affected stakeholders, including the cities-adjacent to the project, local watersheds and functional units of the Minnesota Department of Transportation. During the corridor hydrology, hydraulics, and water quality phase, system design and regulatory standards were reviewed to develop design criteria for the I-494 drainage system. Each Alternative was analyzed to demonstrate the required level of performance and to establish the need and extent of water quality and detention storage facilities.

This study makes no particular recommendation. Instead, it discusses in detail seven feasible alternatives to accommodate storm drainage and water quality along the I-494 corridor. Improvements to this portion of the I-494 corridor are not yet scheduled. Any one of the seven alternatives could be chosen to be carried forward into the design phase. This study is being constructed well in advance of any potential project. Design criteria, permit requirements and existing pipe conditions will influence which alternative is ultimately selected.

Respectfully submitted,

Stanley Consultants, Inc.

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Meeting notes, September 7, 2006, at the City of Richfield

Meeting notes, September 11, 2006, at Nine Mile Creek Watershed District Office

Telephone call report, September 26, 2006 between Stanley Consultants, Inc and Metropolitan Airports Commission

Telephone call report, October 4, 2006 between Stanley Consultants, Inc and FHWA

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Floodplain Areas of the Lower Minnesota River

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MnDOT 1997. MnDOT Maintenance Bulletin Number 97-1; Roadway Accident Scene Vehicle Fluid Spill Response Procedure

Meeting notes, April 26, 2007, at MnDOT

Section 1

Study Background and Approach

Purpose

The purpose of this study is to expand upon the I-494 Drainage Feasibility Study, dated June 2005, and assist the Minnesota Department of Transportation (Mn/DOT) in determining the means for stormwater drainage of I-494 from Penn Avenue to the Minnesota River, and potentially to the west of Penn Avenue to TH169. The previous feasibility study considered conveyance tunnels, storage tunnels, and/or the reuse of the existing storm sewer system as potential solutions to draining I-494. The intent of this report is to explore in more detail the previous preferred Alternatives, as well as other possible solutions born from concerns raised by Mn/DOT during their internal review of the previous studies.

The storm sewer system that serves the corridor has been undersized for many years, and flooding has occurred at low points near the interchanges during more recent years, occasionally forcing the closure of the highway. The current system surcharges during storms approximating the five-year event, well below the Mn/DOT design criteria of, in general, providing protection during the 50-year event.

Maintaining the existing trunk sewer system with no improvements to capacity is the “Do Nothing” alternative. The analysis of the current system clearly shows that it is undersized and does not satisfy current Mn/DOT drainage criteria. Maintaining this system as the primary drainage conduit for I-494 would likely increase the incidence and severity of flooding along the highway and expose the users to an unacceptably high level of risk.

Team and Approach

Stanley Consultants led a team including Wenck Associates (hydrology and hydraulics) in the development of this study. The 2005 report, upon which much of this study is based, was developed by Stanley Consultants and Wenck Associates, assisted by Lyman Henn (tunneling) and Braun Intertec (geotechnology). The approach with the 2007 study was multi-phased: alternative analysis, municipal and agency involvement, corridor hydrology, hydraulics, and water quality, subsurface investigation, exhibits and deliverables.

During the alternative analysis The six preferred Alernatives from previous studies were examined in detail and one additional alternative was added. During the municipal and agency involvement, meetings were held with the affected cities of Richfield and Bloomington as well as the appropriate watersheds. . During the corridor hydrology, hydraulics, and water quality phase, system design and regulatory standards were reviewed to develop design criteria for the I-494 drainage system. During the subsurface investigation, existing geologic information pertaining to the site was reviewed and groundwater sampling was performed at the five piezometers within the 494 corridor. During the (2007) exhibits and deliverables phase, information was developed for presentation to various Mn/DOT functional groups and for inclusion in this report.

This study combines the information developed through the process.

Section 2

Drainage System Design

Design and Regulatory Standards

The following summarizes specific standards relevant to the design of the I-494 drainage system.

Conveyance System

The Mn/DOT Drainage Manual (Section 8.9) states that, *"For ordinary conditions, storm drains should be sized on the assumption that they will flow full or practically full under the design discharge but will not flow under pressure head."* The Manual then has a (conservative) exception for depressed sections where water can only be removed through the storm drain system: *"...in these situations, a 50-year frequency design should be used to design the storm drain which drains the sag point. The main storm drain which drains the depressed section should be designed by computing the hydraulic grade line and keeping the water surface elevations below the grates and/or established critical elevations."*

For this study, we did not allow the 50-year hydraulic grade line to reach the grates; we maintained the hydraulic grade line at the top of the storm pipes so that all stormwater is carried within the pipe without surcharging. This conservative approach is appropriate until a more detailed analysis is undertaken during the final design. There is too much uncertainty regarding transient flows in catch basins and drop shafts to allow water elevations to encroach on the grates during preliminary design. A second criteria used is that the 100-year event will be kept below the grates; i.e. there will be no surface flooding. This is also appropriate at this time as it is assumed that TP-40 will be updated prior to final design of this project.

Outfall Location

Whether the outfall is along I-494 or along I-35W, it will reach the Minnesota River within the Lower Minnesota River Watershed District (LMRWD) and is subject to its' Stormwater Rules.

For drainage routes following I-494 to the river, the outfall would be in the area of West Pond or Almaz Pond or a combination of both West Pond is located under the I-494 Minnesota River bridge. Almaz Pond is located north of 494 and west of TH 5, near the MAC ponds. Current drainage is to established outfalls at Almaz Pond and West Pond. Almaz Pond cannot be enlarged due to planned expansion of the National Cemetery. An outfall at I-35W and the Minnesota River would be on City of Bloomington and United States Fish and Wildlife Service (USFWS) lands.

Minnesota River at West Pond, Looking Upstream
Figure 2-1

Rate Control

The LMRWD requires that post-project peak runoff rates not exceed those from the pre-project condition. The proposed conditions peak discharge is controlled by the existing trunk system capacity, not the runoff rate, during both the 50- and 100-year storms. Significant surface flooding and surcharging of the system act to store water and limit discharge. Our evaluation showed that the peak discharge from the existing system under proposed

conditions (including discharge from Almaz Pond) to the Minnesota River was 433 cfs from the 50-year storm, and 467 cfs from the 100-year storm. Rate control facilities would be required to limit the peak discharge from the proposed system.

However, discussions were held with the LMRWD and their board to discuss whether an exception to their runoff rate limitations may be possible. The Board agreed that the detention time required to limit peak discharge is too short to reduce peak flood stages on a river the size of the Minnesota. In addition, by detaining water in the system, it is more likely to reach the river at the same time as larger flood flows from the upstream portion of the river watershed. Similar exceptions have been made in the past, but cannot be finalized until the project is in the permitting phase. When the project is developed for construction, Mn/DOT will revisit this matter with the LMRWD. (See Appendix H for discussions with the LMRWD and Resolution.)

Water Quality

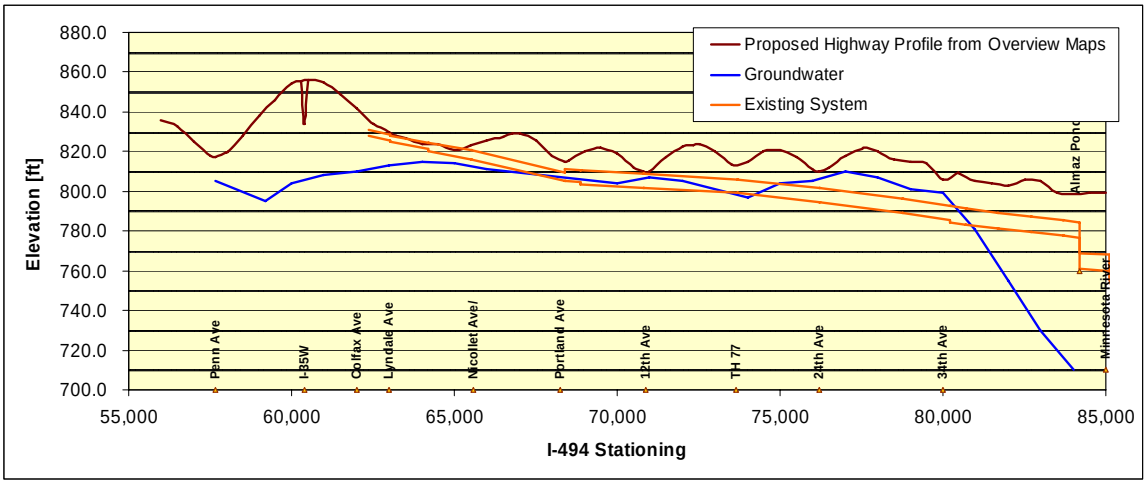
The Minnesota River is classified as a Level II/Level III Water Resource within the LMRWD Classifications. Water quality detention ponds are required as listed in Section 5.13.3 of the LMRWD Watershed Management Plan. The LMRWD objective is to develop an average residence time of about 16 days and remove approximately 50 percent of inflow phosphorus.

The dead volume requirement is equal to runoff from a 2.5-inch, 24-hour storm over the entire subwatershed, or over the entire project site for the on-site basins. For this project, the volume of runoff from this event is 52 acre-feet. The available dead volume at the existing water quality pond (Almaz Pond) is 19 acre-feet; therefore, another pond or a system of ponds is required to provide an additional 33 acre-feet of dead storage.

Watershed and Drainage System Evaluation Model

Our team used the XP-SWMM computer model to evaluate the hydraulic performance of alternative drainage systems. XP-SWMM is the commercial version of the USEPA's Stormwater Management Model. It is a dynamic model which simulates rainfall runoff and performs hydraulic routing of discharge through pipe, pond, and channel systems with free-surface and pressurized flow.

The model describes the hydrologic characteristics of the watershed as well as the sizes, grades, and capacities of the conveyance system. The XP-SWMM model is based on the model developed for the Tunnel Feasibility Study (TFS, 2002). The model was further refined for the Drainage Feasibility Study (DFS, 2005). Our team reviewed the model basic inputs at the beginning of this study and made improvements to the model to support the revised and updated groundwater information.



Proposed I-494 Profile, Existing Trunk Sewer System Profile
Figure 2-2

Contributory Flow

Much of the stormwater conveyed by the project drainage system is generated away from the I-494 right-of-way, as shown in the following table.

Table 2-1 Source of Runoff

Source of Runoff	Drainage Area (ac)	Runoff Volume, 50-year (ac-ft)	Runoff Volume, 100-year (ac-ft)
Mn/DOT R/W	240.9 (57%)	82.3 (60%)	93.7 (59%)
Airport	10.2 (2%)	3.0 (2%)	3.5 (2%)
Bloomington	36.0 (8%)	13.7 (10%)	15.4 (10%)
Richfield	83.0 (20%)	27.5 (20%)	31.4 (20%)
VA	53.0 (13%)	11.5 (8%)	13.7 (9%)
Totals	423.1 (100%)	138.0 (100%)	157.7 (100%)

I-494 and Penn Avenue – Looking West
Figure 2-3

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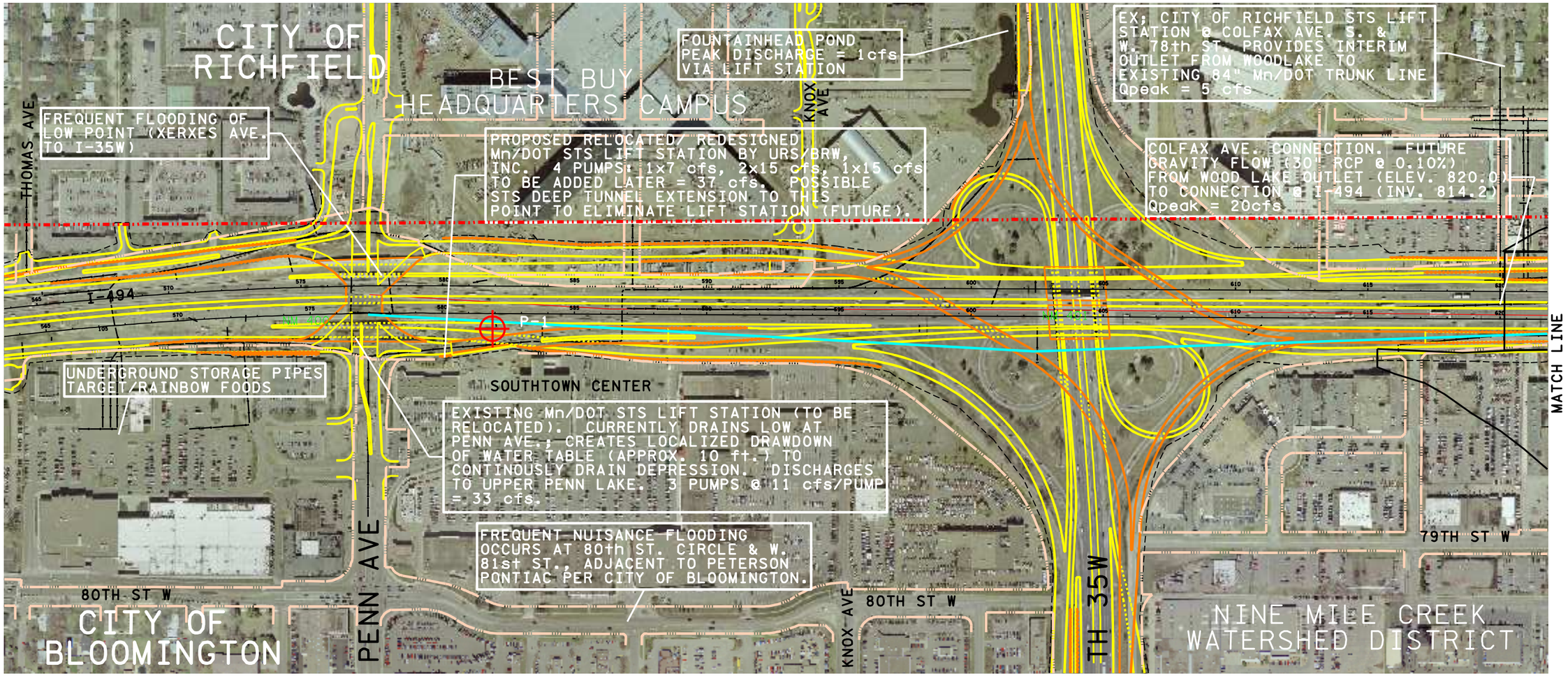

PROPERTY LINE
EXISTING STORM SEWER
PROPOSED ROADWAYS
DRAINAGE AREA BOUNDARY
PROPOSED STORM SEWER/TUNNEL
MUNICIPAL BOUNDARY
PROPOSED BRIDGES
PIEZOMETER LOCATION

N

SCALE: 1" = 400'

DRAINAGE DESIGN
FIGURE 2-4
PLAN
I-494 DRAINAGE FEASIBILITY STUDY

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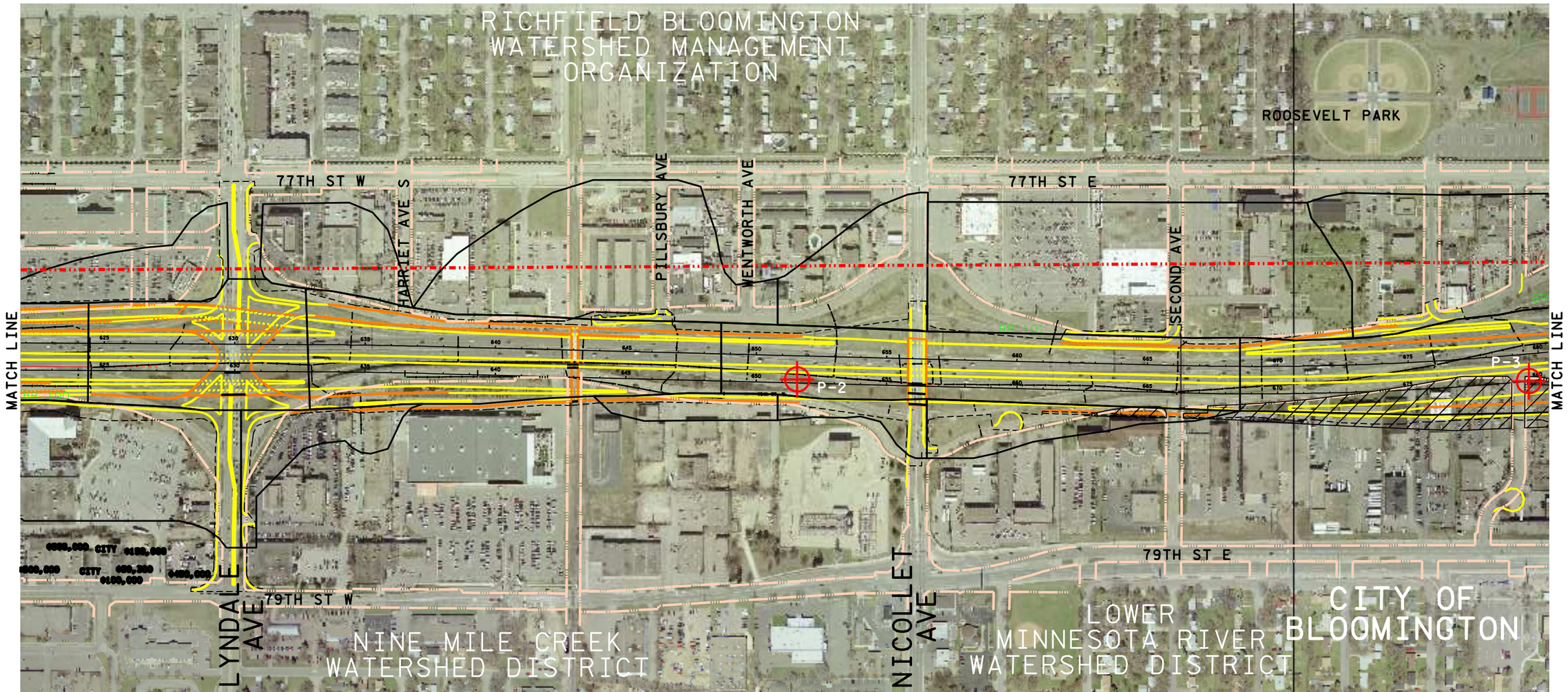

PROPERTY LINE
EXISTING STORM SEWER
PROPOSED ROADWAYS
DRAINAGE AREA BOUNDARY
PROPOSED STORM SEWER/TUNNEL
MUNICIPAL BOUNDARY
PROPOSED BRIDGES
PIEZOMETER LOCATION

N

SCALE: 1" = 400'

DRAINAGE DESIGN
FIGURE 2-5
PLAN
I-494 DRAINAGE FEASIBILITY STUDY

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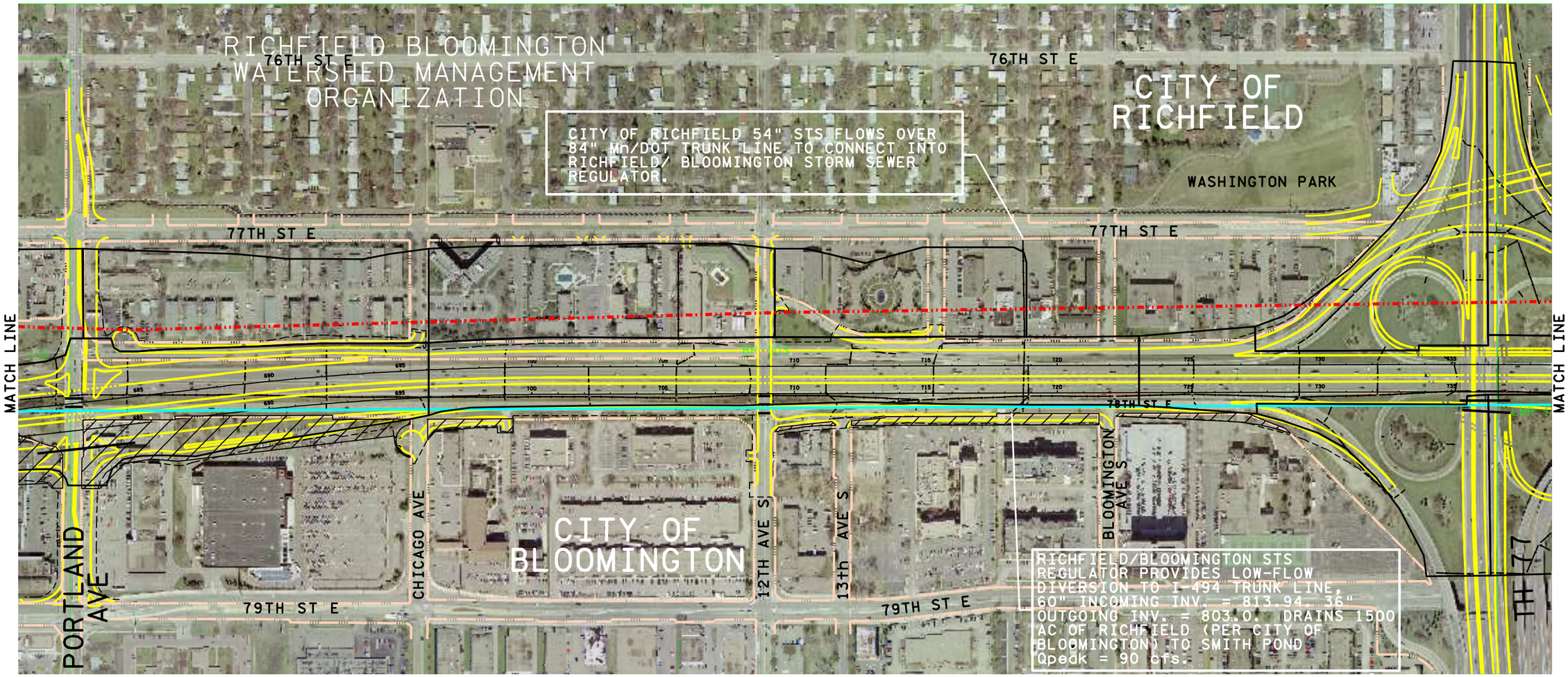

PROPERTY LINE
EXISTING STORM SEWER
PROPOSED ROADWAYS
DRAINAGE AREA BOUNDARY
PROPOSED STORM SEWER/TUNNEL
MUNICIPAL BOUNDARY
PROPOSED BRIDGES
PIEZOMETER LOCATION

N

SCALE: 1" = 400'

DRAINAGE DESIGN
FIGURE 2-6
PLAN
I-494 DRAINAGE FEASIBILITY STUDY

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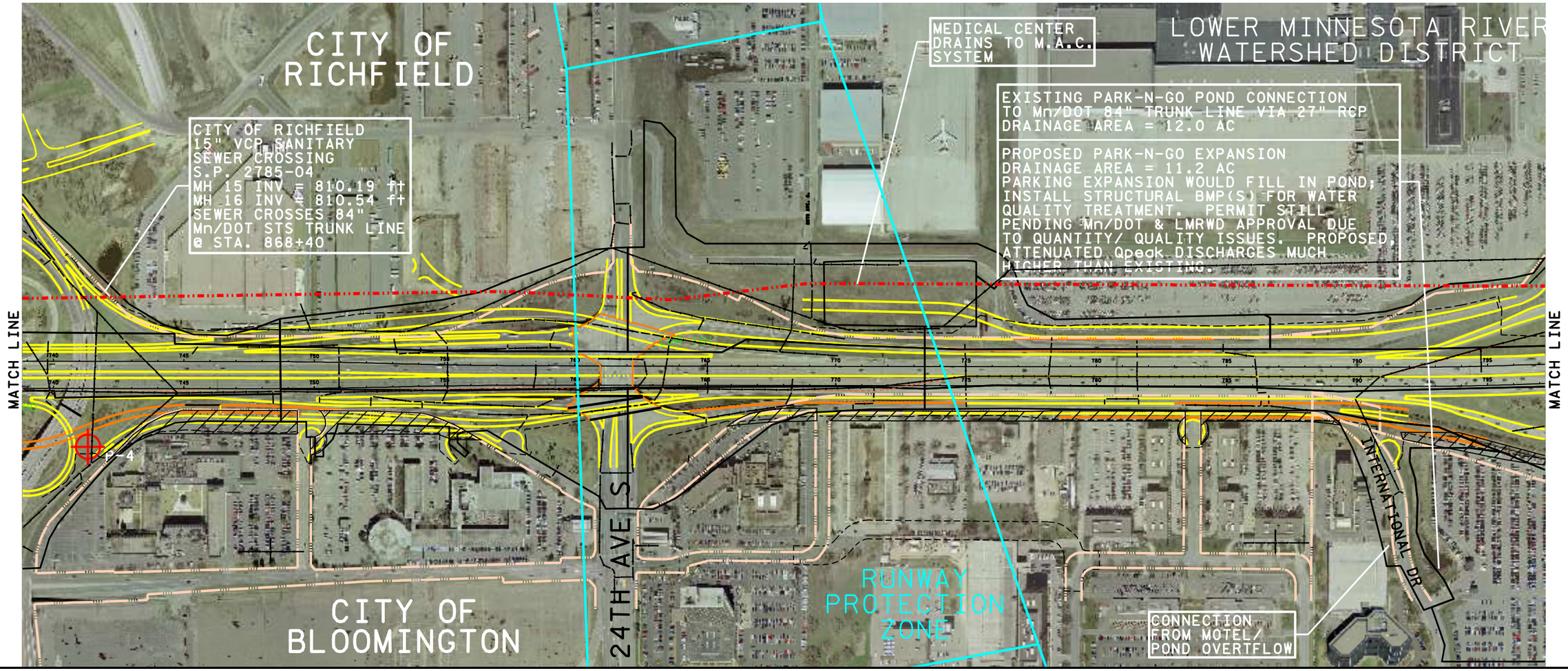

PROPERTY LINE

EXISTING STORM SEWER

PROPOSED ROADWAYS

DRAINAGE AREA BOUNDARY

PROPOSED STORM SEWER/TUNNEL

MUNICIPAL BOUNDARY

PROPOSED BRIDGES

PIEZOMETER LOCATION

N

SCALE: 1" = 400'

DRAINAGE DESIGN
FIGURE 2-7
PLAN
I-494 DRAINAGE FEASIBILITY STUDY

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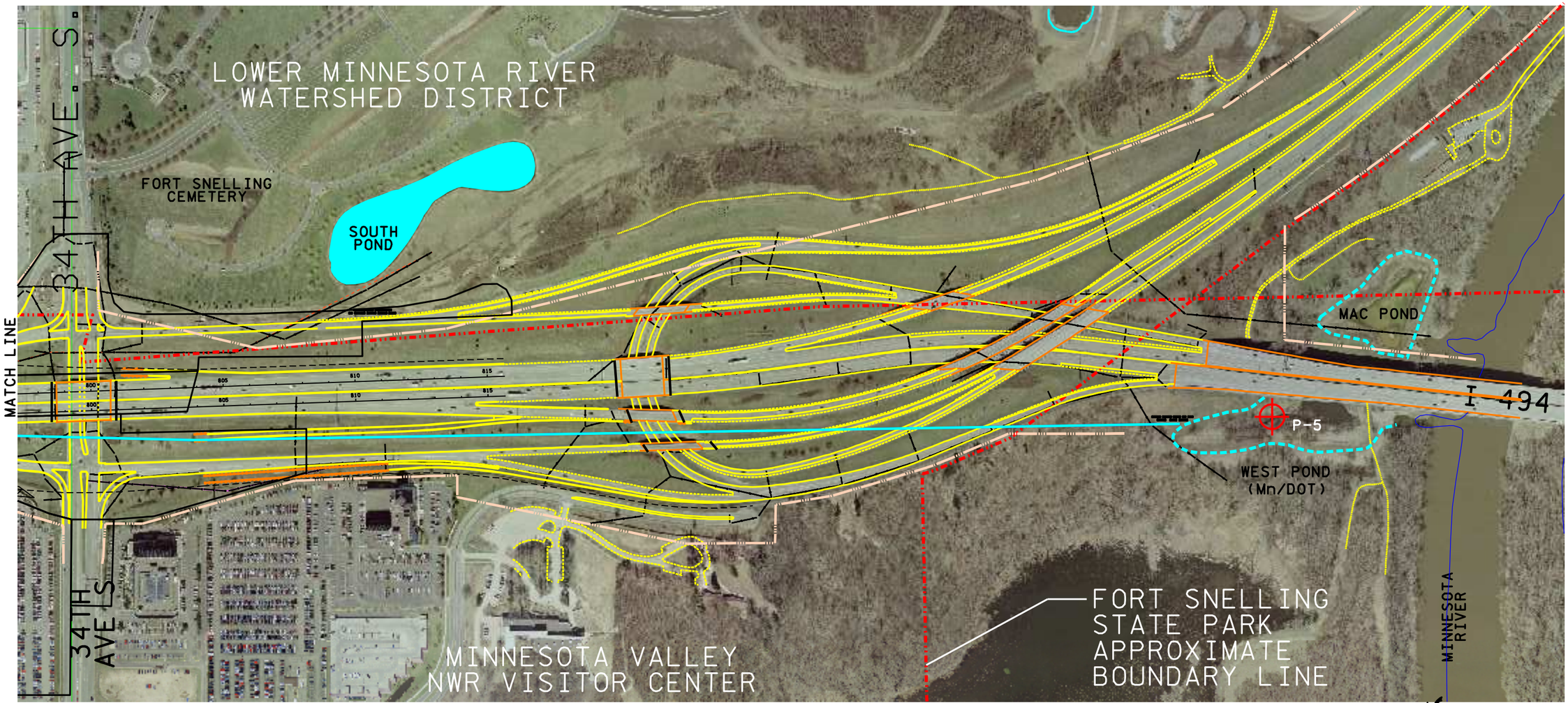

PROPERTY LINE
EXISTING STORM SEWER
PROPOSED ROADWAYS
DRAINAGE AREA BOUNDARY
PROPOSED STORM SEWER/TUNNEL
MUNICIPAL BOUNDARY
PROPOSED BRIDGES
PIEZOMETER LOCATION

N

SCALE: 1" = 400'

DRAINAGE DESIGN
FIGURE 2-8
PLAN
I-494 DRAINAGE FEASIBILITY STUDY

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Section 3

Alternatives Development

Primary Alternatives

During the development of the 2005 Drainage Feasibility Study, various alternative drainage schemes were developed. A scoping workshop clarified objectives and identified potential solutions. The alternatives are described below:

- Reuse the existing trunk sewer (or replace with a similar shallow, cut-and-cover storm sewer) and provide supplemental surface pond storage or supplemental underground storage to provide rate control and water quality storage. To reuse the existing storm sewer assumes that it will be in a restorable condition at the time I-494 is re-constructed.
- Construct a conveyance tunnel, or conveyance/detention storage tunnel.
- Install parallel storm sewers to augment the capacity of the existing drainage system.
- Increase pumping to adjacent watersheds through increased use of existing pump stations combined with the addition of supplemental pump stations to eliminate need for additional drainage infrastructure.
- Route the drainage outside the I-494 corridor, using alternative corridors to the south such as along I-35W or TH 77, or by using a direct route under private properties from the highway to the River.

Initial Hydraulic Analyses

Before additional consideration could be given to the alternatives, initial hydraulic modeling was required.

Task 1 – Verify Existing Model

Task 1a verified that the XP-SWMM model accurately represents the existing stormwater system, and confirmed that it simulated known flooding conditions. The 50-year simulation

demonstrated surcharging in most pipe segments, and surface flooding at several locations. The 100-year simulation demonstrated surcharging and flooding to a greater degree. The model indicates relatively small increases in the maximum discharge rate between the 50 and 100-year simulations, since existing undersized pipes restrict (and therefore control) discharge rates. The model results confirm that the existing system does not have the capacity to handle existing or proposed drainage conditions. System improvements will be required to limit surcharging and flooding.

Task 1b verified that the XP-SWMM model used simplified drainage subwatersheds and that a detailed layout of proposed surface collection system was not required. The base model previously established was reviewed for known changes in drainage areas, high points and subwatershed divides, and for basic input parameters. The model does not include detailed drainage system modeling (i.e. to catch basin level). The level of detail in the base model is considered adequate to answer the large-scale questions of the drainage feasibility study, including storage, conveyance, and water quality.

Task 2 – Establish Maximum Capacity of Existing System from Downstream

The existing water quality basin for this system is Almaz Pond, located adjacent to the National Cemetery, just upstream along the Minnesota River. Task 2 determined how much of the existing storm sewer system could be reused. It modeled the in-place system from Almaz Pond upstream to establish how much of the corridor—starting in the east—could be drained using only the existing trunk sewers and Almaz Pond. Any remaining area to the west would have to be drained in a new system. Capacity was evaluated incrementally upstream from Almaz Pond by adding one subwatershed at a time until the existing pipe reached capacity.

The analysis demonstrated that the existing system could drain the corridor from west of 24th Avenue downstream to Almaz Pond. Surcharging and flooding occurred in the system when stormwater was added to the analysis west of 24th Avenue.

Task 3 – Establish Maximum Capacity of Existing System from Upstream

Task 3 was an incremental analysis of pipe capacity from the upstream end of the drainage system working downstream, to determine if upstream portions of the drainage infrastructure could be reutilized under proposed conditions. The results indicate that the upstream end of the system (at Colfax Avenue) is under capacity for the proposed conditions. Surcharging and flooding occur for all trunk sewer segments from Colfax through Portland Avenues at the 50-year design storm. Inclusion of the Penn Avenue drainage only increases flooding conditions.

Task 4 – Estimate Required Detention Storage Volume

Task 4 modeled proposed conditions using the existing sewer to determine the required detention storage volume that would allow continued use of the existing system. In total, 41 acre-feet of live storage is required for detention storage in order to reuse the existing system.

Task 5 – Estimate Required Water Quality Storage Volume

Task 5 estimated water quality storage volume requirements. These volumes were estimated using the runoff volumes from the 1-year (2.5 inch) design storm. In total, 52 acre-feet of dead volume is required for water quality treatment.

West Pond, Looking Southeast
Figure 3-1

Almaz Pond, Looking North
Figure 3-2

Sedimentation

Although Mn/DOT does not use sand for snow and ice control along this section of highway, the accumulation of sediment still occurs. This material can find its way to the site on the tires of vehicles entering from sandy areas, as wind blown debris from off site, or from open topped loads of sand and aggregate that traverse the highway. Under more frequent rainfall events, this material is washed into the stormwater collection system and conveyed downstream. Over time, sediment can accumulate within a storm sewer system, reducing system capacity and exacerbating local flooding. To minimize these adverse consequences, the development of each alternative considered the effects of sedimentation.

A 2005–2006 monitoring study by Mn/DOT (Barr) suggests that the concentration of sediment under typical highway conditions (60 percent highway and 40 percent residential) is approximately 200 to 400 mg/L of runoff. For our site, we could expect the following:

Table 3-1

TSS Concentration in runoff	[mg/L]	300
Annual Precipitation	[in]	30
Annual Runoff Coefficient	[--]	0.4
Watershed Area	[ac]	438
Annual Runoff Volume	[ac-ft]	438
Annual Load	[lb]	357,408
Annual Load (at 80 pcf)	[cu ft]	4,468

By using a consistent street sweeping program, sediment loading of the storm sewer can be reduced by more than 50%. In addition, incorporating well-maintained catch basins and other sediment traps with the storm sewer design can further reduce the volume of sediment that is transported downstream.

Under the tunnel alternative (described in later sections), sediment from the I-494 drainage system would collect both in Almaz and West Ponds in roughly equal proportions. The total suspended sediment load for the I-494 drainage system is estimated as 400,000 lb/yr, or a volume of 5,000 ft^3/yr. (This is based on a typical total suspended solids concentration of 300 mg/L, and equivalent to about 900 lb/acre.) The sediment accumulation in West Pond and in Almaz ponds will reach about 2.3 acre-feet (20 percent) each after 20 years of operation.

See below Table 3-2 for new pond estimated sediment accumulation.

Table 3-2

Storm Precipitation Depth	Percent Annual Precip by Volume	Percent of Storm Volume that Enters Pond	Percent of Annual Precip Volume Entering Pond	Intervening watershed by percent of total	Percent of Total Solids Load	Project Corridor Total Solids Load [lb/yr]	Pond Accumulation cu ft/yr	cu ft /20 yr
Penn								
			100%	3%	3.300%	4,500	149	2,970
Wentworth								
0	0%	0%						
0.7	48%	0%	0%					
2.5	93%	26%	6%					
5.3	98%	34%	2%					
9	100%	31%	1%					
			8%	23%	1.856%	4,500	84	1,670
Portland								
0	0%	0%						
0.7	48%	0%	0%					
2.5	93%	44%	10%					
5.3	98%	71%	3%					
9	100%	62%	1%					
			14%	10%	1.439%	4,500	65	1,295
TH 77								
0	0%	0%						
0.7	48%	0%	0%					
2.5	93%	40%	9%					
5.3	98%	57%	2%					
9	100%	52%	1%					
			13%	29%	3.629%	4,500	163	3,266

Per Mn/DOT's MS4 NPDES General Permit with the MPCA, they are required to inspect 20% of their stormwater ponds each year. At this time, there are roughly 500 ponds in the Metro Area under Mn/DOT control. As such, some 100 ponds each year are inspected. Of the 100 inspected in 2006, about 20 ponds needed repair and /or cleaning. Cleaning takes place when the delta is visible and when ponds are about 50% full of sediment. As such, 20 of 500 ponds needed cleaning, equating to cleaning each pond every 25 years.

Section 4

Alternatives Refinement

Alternatives Development

The approach to previous alternatives development was three phased; scoping, refinement, and comparison. During the scoping phase, numerous potential drainage system alternatives were identified. During the refinement phase, analyses were performed to determine if each alternative was at least physically viable. During the comparison phase, each feasible alternative was compared based on estimated costs, and social and environmental constraints. The practicable preferred alternatives developed during this process and advanced to this study are described below. The numbering scheme developed during previous studies has been maintained.

Six preferred drainage alternatives have been identified for analysis and presentation in this study. The alternatives were identified through a process of the following elements:

1. Hydrologic and hydraulic design standards were developed for drainage of the corridor as documented in Appendix H (Wenck, 2007a).
2. Analysis of the existing drainage system capability to drain the future I-494 using the XP-SWMM hydrologic and hydraulic model developed in the Tunnel Feasibility Study ("TFS"; SRF, 2002). The model was reviewed as documented in Appendix H (Wenck, 2004).
3. Development of a long list of prospective drainage alternatives through a workshop process.
4. Initial analysis of the existing system and narrowing the prospective drainage alternatives to a short list of five (with several sub-alternatives).
5. Refinement of the drainage alternatives with use of the XP-SWMM model to evaluate and develop effective hydraulic designs for each alternative which meet the hydraulic design criteria.

6. Six alternatives were compared on the basis of cost and other factors.
7. Re-evaluation of the six original preferred alternatives with updated input from Mn/DOT, municipalities, watersheds and updated groundwater elevations at the prospective ponding sites. The original six alternatives are as follows along with one new alternative, 2F, which was added to this study.

Table 4-1 Alternatives Compared in Final Report

Alternative 1C	Conveyance Tunnel with no rate control
Alternative 2C	Existing Sewer with Adjacent Surface Ponding
Alternative 2D	Existing Sewer with Buried Ponding Under Highway
Alternative 2E	Existing Sewer with Modified Adjacent and Under Roadway Ponding
Alternative 2F	Existing Sewer with Buried Ponding Under Roadway, Sealed System
Alternative 4A	Conveyance Tunnel along I-35W with Internal Rate Control
Alternative 5A	Storage Tunnel with Gravity Outfall

The final alternatives compared in this study, and their development, are described in the following sections.

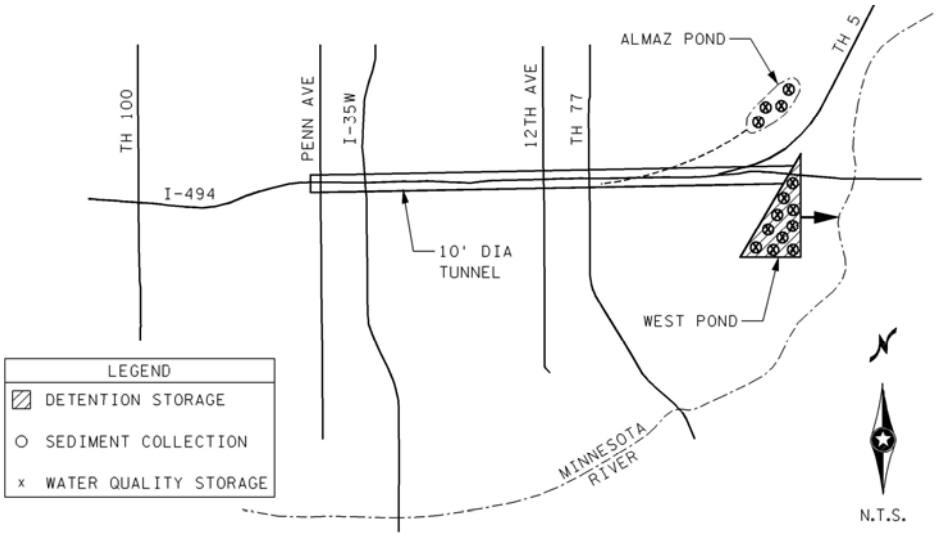
Alternative 1 – Conveyance Tunnel (See Appendix A)

Alternative 1C – 10.0 Foot Conveyance Tunnel with Downstream Detention

Stormwater will be conveyed through a 10-foot diameter tunnel, 27,000 feet in length, from Penn Avenue to the east. Water quality, sediment removal, and detention storage will be provided in West Pond. The tunnel can be constructed to a depth to allow future expansion to the west. This alternative assumes that portions of the existing storm sewer system will be available for reuse as a part of a reconfigured system. To reuse the existing storm sewer assumes that it will be in a restorable condition at the time I-494 is reconstructed.

This requires new ponds at Penn Avenue, Wentworth Avenue, Portland Avenue and TH 77, and storm sewer reconstruction from Colfax Avenue to Portland Avenue. The pond at Penn Avenue is designed to store stormwater before pumping it to the Wentworth pond and reduces the storage volume needed downstream. The pond is sized to contain the entire runoff volume from the 100-year 24-hour storm for the potential case of pump failure. Each pond incorporates wet detention (dead storage) for water quality treatment. Almaz Pond would continue to be used for rate control and water quality detention.

Traditional stormwater detention basins are land intensive and, as property acquisition for the ponds was the largest portion of the total cost, we considered the use of alternative storage schemes, most notably the use of Modular block retaining walls to eliminate the land required for slope grading of the ponds.



Alternative 1C – Conveyance Tunnel with Downstream Detention
Figure 4-1

Alternative 1E – Conveyance System by Cut and Cover

By requiring gravity drainage of Penn Avenue, the system must be so deep that cut and cover trenches would be prohibitively deep and wide. Two conditions were considered – maintenance of the Penn Avenue pump station, and gravity flow from Penn Avenue to the outfall. To eliminate the pump station requires that the storm sewer be lowered approximately 14 feet.

With no pump station, the cuts required to install the storm sewer average over 35 feet, and peak at almost 58 feet. Maintaining 1.5H:1V side slopes, this results in trench widths that average over 125 feet, and maximize at nearly 190 feet, resulting in excavation volumes exceeding 2,750,000 cubic yards.

Maintaining the pump station, the cuts required to install new storm sewer average over 22 feet, and peak at over 34 feet. Maintaining 1.5H:1V side slopes, this results in trench widths that average over 81 feet, and maximize at over 117 feet, resulting in excavation volumes exceeding 900,000 cubic yards.

Due to restrictive widths of the existing right-of-way, and the potential for conflicting utilities and bridge components, this alternative was rejected from further study. Thus, installing new storm sewer pipe through excavation is not an option.

Alternative 2 – Reuse Existing Sewer with Adjacent Ponding

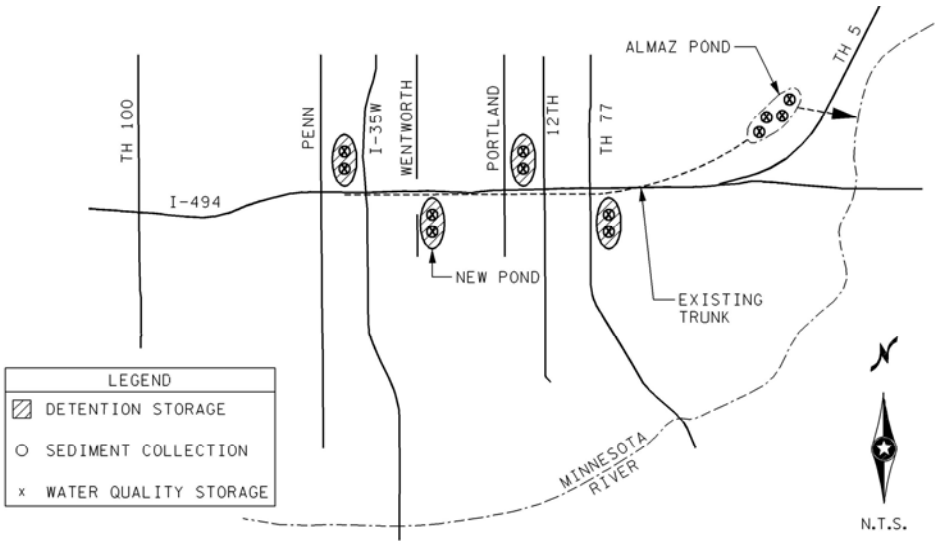
Utilize the existing trunk drainage system, incorporating detention and retention basins along the alignment. The normal water elevation of these basins will approximate the invert of the existing storm sewer system and will reflect area groundwater elevations. The pump station at Penn Avenue will be maintained. These alternatives assume that portions of the existing storm sewer system will be available for reuse as a part of a reconfigured system. To reuse the existing storm sewer assumes that it will be in a restorable condition at the time I-494 is constructed.

Alternative 2C – Use Existing Sewer with Adjacent Surface Ponding, Penn Avenue Detention (See Appendix B)

This requires new ponds at Penn Avenue, Wentworth Avenue, Portland Avenue and TH 77, and storm sewer reconstruction from Colfax Avenue to Portland Avenue. The pond at Penn Avenue is designed to store stormwater before pumping it to the Wentworth pond and reduces the storage volume needed downstream. The pond is sized to contain the entire runoff volume from the 100-year 24-hour storm for the potential case of pump failure. Each pond incorporates wet detention (dead storage) for water quality treatment. Almaz Pond would continue to be used for rate control and water quality detention.

Traditional stormwater detention basins are land intensive and, as property acquisition for the ponds was the largest portion of the total cost, we considered the use of alternative storage schemes, most notably the use of Modular block retaining walls to eliminate the land required for slope grading of the ponds.

In Alternative 2C, multiple ponds provide detention storage and water quality redundancy. It can be constructed with local expertise but has less upstream expansion potential than tunnel alternatives. This alternative requires ongoing maintenance to limit sedimentation and maintain a pump station.



Alternatives 2C – Use Existing Sewer with Adjacent Ponding
Figure 4-2

Alternative 2D – Use Existing Sewer with Buried Ponding under Roadway (See Appendix C)

Detention storage will be provided in buried storage cells constructed at four locations along the alignment. Water quality will be provided at West Pond. Almaz Pond would continue to be used for rate control and water quality detention. Sediment removal would occur at the intake level to minimize the volume of material that enters the storage system. The Penn Avenue discharge will be pumped.

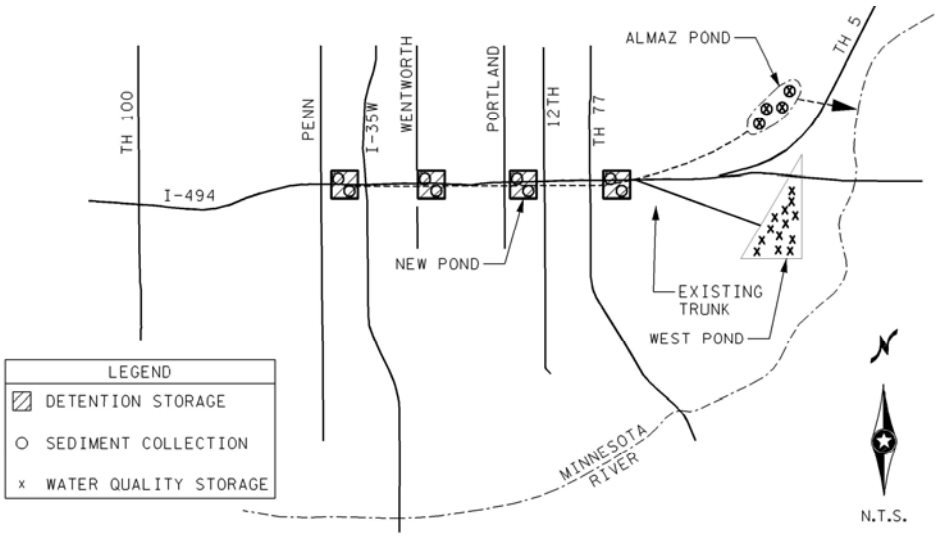
The storage cells will be located at highway low points and will be constructed of multiple buried cells. On the heavy end, these could be configured from multiple 10 foot high by 14 foot wide pre-cast box culvert sections. Although the anticipated bounce in the various detention storage ponds varies between 1.3 and 6.2 feet, the 10 foot height provided within the culvert sections allows ample headroom during maintenance if required. However, if sediment could be effectively captured upstream of the storage cells or conveyed past the storage cells, the maintenance headroom requirement could be eliminated and the cell height reduced considerably.

Sediment collection within the system would be accomplished through effective design. Catch basin or sediment traps would be incorporated into the proposed stormwater collection system. In addition, the splitter structures (designed to send stormwater to the storage facilities at the right time) can be designed such that most low flow events (where the bulk of sediment transport occurs) would be maintained within the mainline storm sewer. As such, most sediment that made it past the catch basins would be transported downstream and into Almaz or West ponds. Sumps would be provided between the splitter structures and storage cells to collect sediment that accompanied high flow events.

At this time, there are numerous manufacturers of buried stormwater detention products. These are typically configured as long rows of HDPE arch sections or pre-cast concrete shapes, installed in parallel banks and interconnected with a manifold at one or both ends. The construction cost of these systems can be significantly less than the cost of the concrete box culvert-based storage system.

Conversations with the FHWA (Dan Ghere, Appendix I) revealed that there are no locations in the Midwest where detention storage is provided under Interstate pavement. However, this methodology is becoming increasingly popular and refined in the commercial and municipal arenas, as property values continue to rise and areas become more densely developed. Mr. Ghere opinioned that it was just a matter of time before economics and maturing technology combine to place these systems under major highways.

In this alternative, multiple ponds provide detention storage and water quality redundancy. This Alternative can be constructed with local expertise, but requires ongoing maintenance to limit sedimentation and maintain the pump station.



Alternative 2D, 2E & 2F – Use Existing Sewer with Buried Ponding under Highway
Figure 4-3

Alternative 2E – Existing Sewer with Modified Adjacent and Under Roadway Ponding (See Appendix D)

This alternative is based upon Alternatives 2C and 2D with the changes primarily in the configuration and physical location of the four stormwater ponds. As above, ponds (storage facilities) will be needed at Penn, Wentworth, Portland, and TH77. The intent of this alternative was twofold. First, the ponds and storage cells were to minimize the amount of private property required to provide detention storage. Second, the use of storage cells within the highway right-of-way and directly under the mainline roadway pavement should be minimized to reduce construction impacts or disruption to traffic during maintenance activities.

Sediment removal and detention storage will be provided in a combination of ponds and buried storage cells constructed at four general locations along the alignment. Water quality and sediment removal will be provided at each pond, or at West Pond as required. The Penn Avenue discharge will be pumped from the detention pond into the existing storm sewer system to the east.

This requires new ponds at Penn Avenue, Wentworth Avenue, Portland Avenue and TH 77, and storm sewer reconstruction from Colfax Avenue to Portland Avenue. The pond at Penn Avenue is designed to store stormwater before pumping it to the Wentworth pond and reduces the storage volume needed downstream. The pond is sized to contain the entire runoff volume from the 100-year 24-hour storm for the potential case of pump failure. Each pond incorporates wet detention (dead storage) for water quality treatment. Almaz Pond would continue to be used for rate control and water quality detention.

Traditional stormwater detention basins are land intensive and, as property acquisition for the ponds was the largest portion of the total cost, we considered the use of alternative storage schemes, most notably the use of Modular block retaining walls to eliminate the land required for slope grading of the ponds.

In this alternative, multiple ponds provide detention storage and water quality redundancy. This can be constructed with local expertise, but requires ongoing maintenance to limit sedimentation and maintain the pump station.

Alternative 2F – Use Existing Sewer with Buried Ponding under Roadway, Sealed System (See Appendix E)

Similar to Alternative 2D, detention storage will be provided in buried storage cells constructed at four locations along the alignment. Water quality will be provided at West Pond. Sediment removal would occur at the intake level to minimize the volume of material that enters the storage system. The Penn Avenue discharge will be pumped.

This requires new ponds at Penn Avenue, Wentworth Avenue, Portland Avenue and TH 77, and storm sewer reconstruction from Colfax Avenue to Portland Avenue. The pond at Penn Avenue is designed to store stormwater before pumping it to the Wentworth pond and reduces the storage volume needed downstream. The pond is sized to contain the entire runoff volume from the 100-year 24-hour storm for the potential case of pump failure. Each pond incorporates wet detention (dead storage) for water quality treatment. Almaz Pond would continue to be used for rate control and water quality detention.

Traditional stormwater detention basins are land intensive and, as property acquisition for the ponds was the largest portion of the total cost, we considered the use of alternative storage schemes, most notably the use of Modular block retaining walls to eliminate the land required for slope grading of the ponds.

As with Alternative 2D, the storage cells will be located at highway low points and will be constructed of multiple buried cells. The bounce at each pond is restricted by the groundwater elevation and by the proposed pavement sag elevation. With Alternative 2D, these restrictions limit the available bounce at Portland and TH 77 to below 2 feet. With

Alternative 2F, the proposed box culvert sections are sealed against groundwater infiltration and lowered five feet at Portland and TH 77. This results in a much greater range of bounce and a proportionately smaller footprint for the storage cells.

Total cell area under this Alternative is reduced from 24.4 acres (Alt. 2D) to 8.4 acres. This 66% reduction in required storage area results in a significant cost savings.

Since this system would be installed below the current local groundwater elevation, there is a slight possibility that the groundwater would be lowered should the seal (an HDPE liner) fail. To minimize this potential, the seal could be constructed using continuous sheets of HDPE placed upon a bedding layer of aggregate. A layer of cushioning sand would be placed atop the liner to protect it from the culvert sections. The liner would be wrapped over the sides of the installation and joined to another continuous sheet placed over the top of the culvert sections. Perforated pipes could be placed within the sand layer and used monitor for any infiltration.

Sediment collection within the system would be accomplished through effective design. Catch basin or sediment traps would be incorporated into the proposed stormwater collection system. In addition, the splitter structures (designed to send stormwater to the storage facilities at the right time) can be designed such that most low flow events (where the bulk of sediment transport occurs) would be maintained within the mainline storm sewer. As such, most sediment that made it past the catch basins would be transported downstream and into Almaz or West ponds. Sumps would be provided between the splitter structures and storage cells to collect sediment that accompanied high flow events.

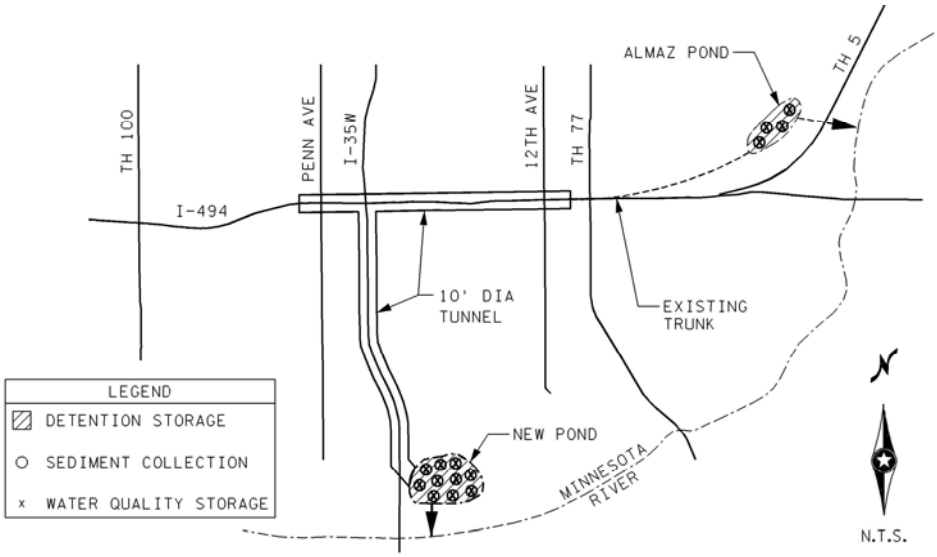
In this alternative, multiple ponds provide detention storage and water quality redundancy. This Alternative can be constructed with local expertise, but requires ongoing maintenance to limit sedimentation and maintain the pump station.

Alternative 4 – Conveyance Tunnel along I-35W

Convey stormwater to a tunnel constructed within the I-35W corridor. A portion of the drainage would be through the existing trunk sewer system to the east to Almaz Pond. The pump station at Penn Avenue will be eliminated as a part of this alternative. Outfall conditions would require permission through the U.S. Fish and Wildlife Service (land managed by the City of Bloomington), but there is some support from the City to construct this alternative to accommodate their future drainage needs. As well, the City owns various parcels along the alignment which could be used for stormwater treatment and detention. However, the City has expressed their need to solve their drainage problems in the near term. As such, they have indicated that work on I-494 would need to be advanced within the next decade for them to lend their support to this scheme. This alternative assumes that portions of the existing storm sewer system will be available for reuse as a part of a reconfigured system. To reuse the existing storm sewer assumes that it will be in a restorable condition at the time I-494 is constructed.

Alternative 4A – Conveyance Tunnel along I-35W with Downstream Detention (See Appendix E)

Stormwater will be conveyed through a 9 foot diameter tunnel between Penn Avenue and 12th Avenue, and then to the south along the I-35W corridor. At the downstream end of the tunnel, water quality, sediment removal, and detention storage will be provided in a new pond adjacent to the Minnesota River.



Alternative 4A – Conveyance Tunnel along I-35W with Downstream Detention
Figure 4-4

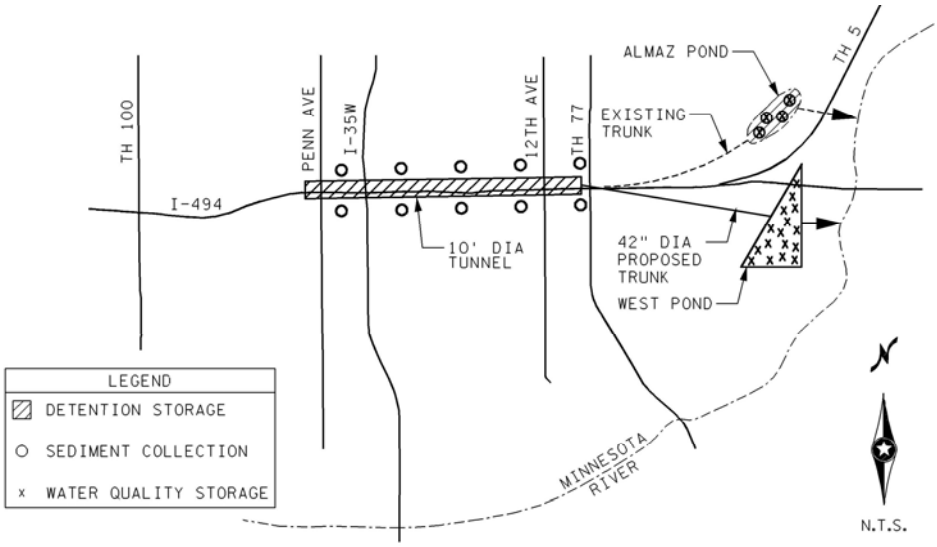
Alternative 5 – Storage Tunnel

Provide required detention storage in a 12-foot diameter tunnel. Due to the low velocities anticipated in the storage tunnel, sediment collection will be provided upstream of the storage facility. The pump station at Penn Avenue will be eliminated. The tunnel can be constructed to such a depth as to allow for future expansion to the west. This alternative assumes that portions

of the existing storm sewer system will be available for reuse as a part of a reconfigured system. To reuse the existing storm sewer assumes that it will be in a restorable condition at the time I-494 is constructed.

Alternative 5A – Storage Tunnel with Gravity Outfall (See Appendix F)

Stormwater will be collected in a large tunnel from Penn Avenue to 12th Avenue. The tunnel will be 12 feet in diameter and 16,000 feet in length. At the downstream end of the storage tunnel, an orifice will control the discharge of storm flows into a new 42-inch diameter microtunnel draining to the east. Water quality storage will be provided in West Pond and Almaz Pond. To reduce the volume of particulates collecting in the tunnel, sediment collection will occur upstream of the tunnel in purpose-built catch basins.



Alternative 5A – Storage Tunnel with Gravity Outfall
Figure 4-5

Section 5

Alternatives Comparison

Comparison Factors

We identified quantitative and qualitative factors to compare the alternatives.

Quantitative Factors

Quantitative factors are those that can be dollar denominated. Section 7 shows the results of the quantitative analysis. The upfront costs, including engineering, design, property acquisition and construction costs range from $75 Million to $179 Million with Alternative 2F (reuse of existing sewer with under roadway storage and sealed groundwater) being the least expensive. When adding in the continuing costs, made up of maintenance costs, loss of property tax revenues, and necessary reconstruction of some components at Year 40 (reported as a present value of the 80 year design life of the project) were added, the project costs varied from $79 Million (Alternative 2F) to $206 Million (Alternative 2C)

Cost estimates were prepared for each alternative using unit pricing from recent similar projects, Mn/DOT Average Bid Prices, and local pricing conditions. Construction of Alternatives 2A, 2C, and 2E require land for detention storage and water quality ponds. Construction of the other alternatives required land for tunnel access shafts at multiple locations. Some alternatives require the reconstruction of West Pond for detention storage and water quality purposes.

Right-of-way costs include acquisition, relocation, and demolition. Acquisition costs were determined by using 200% of the estimated value as published on the Hennepin County tax rolls. 200% was adopted as per the recommendation of the Cities.

Loss of property tax revenue from acquired properties for construction occurs in both the Cities of Bloomington and Richfield, depending on the Alternative. We assumed that established businesses would continue to be viable after relocation; there will be no long-term

change to sales or employment tax revenues. Property tax revenues were calculated as a present worth of 30 annual payments and a rate of return of five percent.

As above, the quantitative analysis was based upon an eighty-year design life (the anticipated useful life of the tunnel option). Specific quantitative factors are listed below.

- Pre-Construction factors include the costs of engineering and design, right-of-way, relocation and demolition.
- Construction factors include the actual construction costs, and the cost of construction management.
- Post-Construction costs include operation and maintenance and a reduction of the cities' tax base.

Qualitative Factors

For the qualitative analysis, a comparison between alternatives is subjective. The analysis indicated that tunnel alternatives 1C (tunnel with downstream detention), 4A (tunnel along I-35W with downstream detention), and 5A (storage tunnel with gravity outfall) had comparatively mild impacts, while alternatives 2C, 2D, 2E, 2F had relatively significant impacts.

Factors considered during this analysis are listed below.

- Pre-Construction factors include interagency coordination required during scoping and preliminary design, anticipated agency support, and public perception of the project.
- Construction factors include utility impacts, duration of construction, settlement impacts, temporary flooding, water quality, and effects on wetlands.
- Post-Construction factors include suitability for future westward expansion, maintenance, risk of failure or flooding, corridor aesthetics, groundwater quality, surface water quality, quantity of discharge, and the design capacity of the proposed storm sewer system.

Consideration was also given to the Draft Environmental Impact Statement for the I-494 corridor, as written in 1990. Since then, Mn/DOT has worked to respect the specific right-of-way limits proposed in that document. The cost of property acquisition in this area is compounded by the loss of property tax revenues for the Cities of Richfield and Bloomington. For the more land intensive solutions (Alternatives 2A, 2B, and 2C), the benefit to the cities is markedly less than the cost of their reduced tax base. Although the purchase of property is possible, acquisition of large parcels in this area is politically undesirable.

In addition, as project funding becomes more difficult to secure, it is believed that there is a greater likelihood of project success if the project could be constructed independently and in advance of the roadway improvement project, or constructed in stages along with advancing portion of the roadway reconstruction effort. As such, the preferred alternative should be one

that either minimizes traffic disruptions during construction or where portions of the preferred alternative can be constructed independently of others.

In recent years, operations budgets have resulted in increased efficiencies and the desire to develop less maintenance intensive solutions to transportation problems. While the estimated project costs include a cost for maintenance, the ability to budget these maintenance funds for the design life of the facility is not assured. Therefore, the preferred alternative could be one that eliminates the need for pump stations, and minimizes future maintenance requirements.

Stakeholder Input

During the study process, meetings were convened with major stakeholders, including Mn/DOT functional groups, the Cities of Bloomington and Richfield, the Nine Mile Creek Watershed District, and the Lower Minnesota River Watershed District. Their comments and concerns are summarized in the detailed appendices.

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 1C	**Conveyance Tunnel**	Lower MN Watershed permit required				x	
	Construct new 120" conveyance tunnel from Penn Avenue to West Pond.	Volume reduction on municipal boundary basis[1]			x	x	
		Less land needed			x		x
		Improved water quality and sediment removal[2]			x	x	
		West pond can handle the water					x
	Detention & water-quality in newly configured West pond and Almaz	Provides some rate control				x	
		MAC received okay to discharge to the river at a higher rate[3]				x	
	Potential for expansion west of Penn Avenue	May be cheaper since no need to acquire land[6]	x	x			x
	Upstream sediment collection	Logical area for buried storage		x			
	Outfall at West Pond and Almaz Pond	Eliminate pump at Penn Ave.[4]	x	x			x
		Various maintenance possibilities[5]		x			
		Locally much easier	x	x			
		Volume (rate control) is a problem[17]				x	
		Richfield would not invest in a cost share option on a percentage basis		x			
		Phosphorus removal still needed[11]				x	x
		Limited large scale storage examples[15]	x	x	x		x
		Minimal effect on river or adjacent properties[12]					x
		Storage concerns[13]	x			x	x
		Maintenance concerns[14]	x				x
		Expensive	x	x			x
		Potential for additional storage at West Pond					x

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ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 2C	**Existing Sewer with Adjacent Ponding**	Ponds easier to clean			x	x	x
		Meets water quality standards			x		x
	Rehabilitate and reuse the in place storm sewer.	Decision needed soon[10]	x				
	Provide detention and water quality storage in new	Provide all needed sediment and phosphorus removal					x
	ponds constructed adjacent to the highway.	Possibly pump water to Wood Lake		x			
		Use a tunnel from Penn to Lyndale and then ponds east of Lyndale		x			
	Ponds provided at four locations for detention and	Water can drain into Almaz (state pond)					x
	water quality storage - Penn Ave., Wentworth Ave.,	Additional space may be available for underground storage[9]	x				
	Portland Ave., and TH77.	Richfield has many older sites in need of redevelopment	x				
	Penn Ave stormwater will be pumped	More land needed[19]			x		
	Pipes upstream of Portland are replaced	Ponds 20 feet below ground					x
	Doesn't use West Pond	Restricted by pipe capacity[20]					x
	Uses Almaz Pond for water quality	Resistance from Cities[8]	x	x			
	Outfall is at Almaz	Lower MN Watershed permit required				x	
		Existing system does not cover entire corridor					x
		Pond locations subject to change	x	x			
		Maintenance component to upstream sediment basins	x				x
		Economical loss[22]	x	x			
		Expensive land[21]	x	x			x
		Existing pipe deterioration					x
		Existing pipe relining					x
		Potential for additional storage at West Pond					x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 2D	**Existing Sewer with Buried Storage**	Expensive land[21]	x	x			
	Rehabilitate and reuse the in place storm sewer. Provide detention storage in storage cells placed beneath the highway.	Meets water quality standards			x		x
		West pond can handle the water					x
		Decision needed soon[10]	x				
		Provide all needed sediment and phosphorus removal					x
	Ponding at Penn, Wentworth, Portland, and TH 77	Possibly pump water to Wood Lake		x			
	Penn Ave stormwater will be pumped	Use a tunnel from Penn to Lyndale and then ponds east of Lyndale		x			
	Pipes upstream of Portland are replaced	Water can drain into Almaz (state pond)					x
	Uses West Pond & Almaz Pond for water quality	Additional space may be available for underground storage[9]	x				
		Richfield has many older sites in need of redevelopment	x				
	Ponding is buried under roadway for detention storage only.	More land needed[19]			x		
		Ponds 20 feet below ground					x
		Restricted by pipe capacity[20]					x
		Resistance from Cities[8]	x	x			
		Lower MN Watershed permit required				x	
		Existing system does not cover entire corridor					x
		Pond locations subject to change	x	x			
		Maintenance component to upstream sediment basins	x				x
		Economical loss[22]	x	x			
		Existing pipe deterioration					x
		Existing pipe relining					x
		Do not currently use underpavement storage					x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION	STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 2E	Expensive land[21]	x	x			
Existing Sewer with Buried and Adjacent Ponding	Meets water quality standards			x		x
	West pond can handle the water					x
Rehabilitate and reuse the in place storm sewer.	Decision needed soon[10]	x				
Provide detention and water quality storage in new	Provide all needed sediment and phosphorus removal					x
ponds constructed adjacent to the highway and within	Possibly pump water to Wood Lake		x			
storage cells placed beneath the highway.	Use a tunnel from Penn to Lyndale and then ponds east of Lyndale		x			
	Additional space may be available for underground storage[9]	x				
Ponding at Penn Wentworth, Portland, and TH 77	Richfield has many older sites in need of redevelopment	x				
Uses West Pond for water quality	More land needed[19]			x		
Penn Ave. Pond is pumped	Ponds 20 feet below ground					x
Uses Almaz Pond for water quality	Restricted by pipe capacity[20]					x
	Resistance from Cities[8]	x	x			
	Lower MN Watershed permit required				x	
	Existing system does not cover entire corridor					x
	Pond locations subject to change	x	x			
	Maintenance component to upstream sediment basins	x				x
	Aboveground Ponds easier to clean			x	x	x
	Economical loss[22]	x	x			
	Existing pipe deterioration					x
	Existing pipe relining					x
	Do not currently use underpavement storage					x
	Potential for additional storage at West Pond					x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 2F	**Existing Sewer with Buried Storage, Sealed System**	Expensive land[21]	x	x			
		Meets water quality standards			x		x
		West pond can handle the water					x
		Decision needed soon[10]	x				
	Rehabilitate and reuse the in place storm sewer. Provide detention storage in storage cells placed beneath the highway.	Provide all needed sediment and phosphorus removal					x
		Possibly pump water to Wood Lake		x			
		Use a tunnel from Penn to Lyndale and then ponds east of Lyndale		x			
		Water can drain into Almaz (state pond)					x
	Ponding at Penn, Wentworth, Portland, and TH 77	Additional space may be available for underground storage[9]	x				
	Penn Ave stormwater will be pumped	Richfield has many older sites in need of redevelopment	x				
	Pipes upstream of Portland are replaced	More land needed[19]			x		
	Uses West Pond & Almaz Pond for water quality	Ponds 20 feet below ground					x
		Restricted by pipe capacity[20]					x
	Ponding is buried under roadway for detention storage only.	Resistance from Cities[8]	x	x			
		Lower MN Watershed permit required				x	
		Existing system does not cover entire corridor					x
		Pond locations subject to change	x	x			
		Maintenance component to upstream sediment basins	x				x
		Economical loss[22]	x	x			
		Existing pipe deterioration					x
		Existing pipe relining					x
		Do not currently use underpavement storage					x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 4A	**Conveyance Tunnel Along I-35W**	Pickup some of the I-35W drainage			x		
		Less land needed			x		x
	Construct new 120" conveyance tunnel from Penn Avenue to TH 77. Route the tunnel south along I-35W to a new outfall location at the Minnesota River.	Improved water quality and sediment[2]			x	x	x
		Provides some rate control				x	
		MAC received okay to discharge to the river at a higher rate[3]				x	
		Richfield would not invest in a cost share option on a percentage basis		x			
	Uses Almaz Pond for Water quality and detention	Expensive					x
	Eliminates Penn Avenue pump station	Eliminate pump at Penn Ave.	x	x			x
	City of Bloomington owns various parcels along I-35W alignment - could be used for ponds	Various maintenance possibilities[5]		x			
		Water can drain into Almaz (state pond)					x
	Could also accommodate city drainage needs	Locally much easier	x	x			
	Outfall requires permission through US Fish & Wildlife Service (managed by City of Bloomington).	A payback may work with Bloomington[7]	x				
		Volume (rate control) is a problem[17]				x	
		Timeframe off with the City of Bloomington[7]	x				
	Future expansion to west of Penn is possible	Potential problems with US Fish and Wildlife[18]			x	x	
	New pond on I-35W at MN River (water quality & detention)	Maintenance concerns[14]	x				x
		Phosphorus removal still needed[11]				x	x
	Would also be able to drain areas adjacent to I-35W corridor	Storage concerns[13]	x			x	x
		Minimal effect on river or adjacent properties[12]					x
		Potential for additional storage at West Pond					x

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ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 5A	**Storage Tunnel**	Lower MN Watershed permit required				x	
	Construct new 144" storage and conveyance tunnel from Penn Avenue to 12th Avenue South. Rate control outfall is 42" microtunnel from 12th Avenue South to West Pond.	Volume reduction on municipal boundary basis[1]			x	x	
		Less land needed			x		x
		Improved water quality and sediment[2]			x	x	
		West pond can handle the water					x
		Provides some rate control				x	x
	Penn Ave. pump gone	MAC received okay to discharge to the river at a higher rate[3]				x	
	Future expansion to the west possible	May be cheaper since no need to acquire land[6]	x	x			x
	Uses West pond for water quality	Logical area for buried storage		x			x
	Almaz pond will be used for water quality	Eliminate pump at Penn Ave.[4]	x	x			x
		Various maintenance possibilities[5]		x			x
		Water can drain into Almaz (state pond)					x
		Locally much easier	x	x			
		Volume (rate control) is a problem[17]				x	
		Richfield would not invest in a cost share option on a percentage basis		x			
		Phosphorus removal still needed[11]				x	
		Expensive					x
		Minimal effect on river or adjacent properties[12]					x
		Storage concerns[13]	x			x	x
		Maintenance concerns[14]	x				x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION	STAKEHOLDER CONCERNS	
	This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington Richfield Nine Mile Lower MN Mn/DOT

Notes:

1. Water could still be taken down to the river and treated at those ponds.
2. Met water quality standard.
3. Based on the same information as Mn/DOT.
4. The pumps would go into the new system and would not need to be programmed on a hydrograph schedule.
5. These possibilities include: remote control vehicles, future technology, better street sweeping to prevent build up of sediment in the tunnel, and stormcepters.
6. This is already an expensive project. Even if the tunnel ends up costing more, it may be worth the extra expense to avoid having to acquire more land.
7. The City of Bloomington has a much shorter timeframe than Mn/DOT, and needs to provide funding
8. Massive political problems (Richfield's land use plan is already done).
9. This space is located in Bloomington by 24th and I-494 by the airport.
10. Because of all the current construction in these areas, the Cities need to know what land the ponds will be built on so they can to help protect this land.
11. It is needed for longer term detention downstream.
12. This assumes peak flow is allowed without detention.
13. Sediment may get into the tunnel and than it will need to be removed.
14. The tunnel is more difficult to clean out then the surface ponds.
15. Maintenance costs and techniques for buried storage of this magnitude are difficult to calculate because of the lack of existing comparable systems.
16. Not used.
17. Rate control standards are not met.
18. The ponds in Bloomington that are located below the bluff are currently not meeting capacity and need maintenance.
19. This includes land beyond the ROW.
20. This leads to flooding at the low points along the corridor.
21. Richfield would double the property cost listed on the Hennepin County Assessor's site.
22. The combination of cost and disruption to the Cities is very high.

Section 6

Tunnel

Tunnel Layout

A construction shaft will be required at the beginning and end of each tunnel. Additional construction shafts could be placed along the alignment to allow for simultaneous construction of multiple tunnel headings. The Access Shaft should be located at the downstream end of each alignment, so that tunneling could proceed in an uphill direction. The shaft would likely be circular, and would have an approximate diameter of 30-40 feet. For a tunnel project of this size and expected construction duration, a staging area encompassing 4 to 5 acres would be required around the Access Shaft.

An Exit Shaft would be located at the upstream end of each tunnel alignment. Tunneling equipment would be removed from the completed tunnel using the Exit Shaft. In addition, the Exit Shaft could be utilized to facilitate ancillary construction activities such as grouting or pipe placement. The Exit Shaft could have a circular or rectangular configuration, and would be smaller in size than the Access Shaft. Approximate diameters dimensions could be on the order of 15-feet. Since construction activities are not being staged out of the Exit Shaft, only 0.5 acres of land is required for staging in this area.

Additional manhole shafts would be required along the alignment, at a spacing of approximately 700 to 1,000 feet.

Subsurface Conditions

Existing geologic information was reviewed along the I-494 corridor, using borings obtained from Mn/DOT records and existing reports as a starting point. In addition, Braun Intertec performed a limited subsurface investigation as part of this study to obtain geologic information from areas where little information was currently available. Using the boring log sources as described, geologic information was available at a spacing of approximately 500 feet along the I-494 corridor.

The I-494 corridor lies in an environment in which deposition occurred at widely varying rates as a result of fluvial and lacustrine processes related to glaciation and glacial retreat. Geologic cross sections in and around the study area show formations to be widely interbedded which suggest a highly changing and widely braided depositional environment. As a result of the depositional environment of the material in the I-494 corridor, it should be noted that changes in material should be expected within a relatively short distance horizontally or vertically.

Soil conditions appear to be predominantly granular Terrace Deposits from ground surface down to approximately Elevation 780. However, below that elevation, wide variability in soil conditions was evidenced in the borings reviewed, ranging from great thicknesses of sands to significant layers of clays and silts (Glaciolacustrine Deposits). Terrace deposits along the alignment consist primarily of granular materials classified in the Unified System as nonplastic poorly-graded sand (SP), poorly graded sand with silt (SP-SM), and silty sand (SM). This material is generally found beneath 2 feet to 17 feet of fill and ranges from 30 feet thick to more than 100 feet thick. The density of these soils ranged from very loose to very dense with the majority of the soils being loose to medium dense. Glaciolacustrine deposits encountered in the I-494 corridor consist of fine-grained, cohesive soils classified in the Unified System as silt (ML), lean clay (CL), and fat clay (CH). This material ranges in density from medium stiff to very stiff with the majority of the soils being stiff.

Bedrock was not encountered in any of the borings drilled for this program. Groundwater was encountered in all the borings reviewed along the alignments. In general terms, the groundwater surface reflects a muted expression of surface topography. During drilling, groundwater depth was encountered at depths ranging from approximately 10 to 100 feet below ground surface, which corresponds to elevations ranging from El. 710 to El.820. Along the majority of the project corridor, the groundwater level appears to be on the order of 10 to 30 feet below ground surface. However, groundwater levels closer to the Minnesota River on the eastern end of the corridor deepen significantly as the flows make their way to the river.

Anticipated Ground Behavior

In order to select equipment and establish appropriate construction methods for use on tunneling projects, it is necessary for the Contractor to anticipate how the ground will behave in response to tunneling. Ground conditions through which the tunnel will be constructed have been described previously.

Terrace Deposits without binder from clay and silt (SW and SP) are expected to behave as ***running*** ground when above the water table, and ***fast raveling*** to ***flowing*** below the water table. Terrace Deposits with silt or clay binder (SM and SC) are expected to behave as ***slow raveling*** ground above the water table and ***slow*** to ***fast raveling*** or potentially ***flowing*** below the water table.

Glaciolacustrine Deposits include cohesive soils typically classified in the Unified Soil Classification System as CL or CH, with varying degrees of silt. With this classification, it is expected that it will behave primarily as a cohesive material. In terms of the Tunnelman's Classification System, the Glaciolacustrine Deposits are expected to behave primarily as ***firm*** to ***slow raveling*** ground, but potentially with a slight ***squeezing*** behavior if lower strength soils are

encountered. Important to the behavior of these soils is the presence of silt. There are lenses and stringers of low plasticity cohesive and noncohesive silt within the glaciolacustrine soils. The presence of these silt lenses and stringers will modify the behavior of the glaciolacustrine deposits such that ***raveling*** and ***running*** occurs more easily and is more prevalent than without the silt. Additionally, it is possible that the silt lenses and stringers will create small pockets and horizontal tabular voids from ***flowing*** behavior and subsequent piping.

There are expected to be variations within each unit including the presence of thin lenses and stringers of different materials, and similar materials with variations in properties. These conditions create complications for stability and support of the tunnel excavation. Relative to stability of the excavated tunnel, various combinations will result in different stability conditions at different locations around the tunnel, not simply an average of behaviors for the different soil. Poorly behaving soils will tend to undercut or move out from more stable soils. Lenses of poorly behaving soils will tend to result in voids or horizontal tabular voids in more stable soils.

Ground Behavior Relative to Tunnel Excavation

The soils present along the alignment are expected to be well-suited to excavation with an Earth Pressure Balance (EPB) tunnel boring machine (TBM) equipped with a screw auger. In addition, use of a slurry machine could be appropriate, although difficulties should be expected with slurry separation where primarily Glaciolacustrine Deposits are present. Excavation with an open-faced machine is not recommended, due to the location of the groundwater table above the crown of the tunnel. While dewatering operations could likely be performed in the Terrace Deposits, the presence of fine sandy and silty lenses and layers would make this more difficult to perform. Dewatering of the fine-grained Glaciolacustrine Deposits would be difficult to perform on a technical basis, and would likely not be performed. The long-term requirements for dewatering would have economic and environmental impacts to the project which could be easily remedied by using a closed faced tunnel machine.

It will be necessary for the Contractor to maintain positive pressure on the tunnel face in zones where granular soils which exhibit fast raveling to flowing behavior are located within the tunnel horizon, so that settlement criteria for the project are not exceeded. Additionally, it will be necessary to install initial support within the tunnel shield. To control lost ground and settlement it will be necessary to backfill the annulus between the initial support and the excavated tunnel envelope simultaneous with passage of the tunnel shield. Finally, it will be necessary for the TBM to utilize the initial support as a reaction for maintaining face pressure and forward movement.

Ground Behavior Relative to Shaft Construction

The soils present at the shafts are expected to be well-suited to excavation using traditional shaft excavation techniques such as a loader or clamshell. Due to the granular nature of the soils, the unsupported height of the shaft excavations before lagging needs to be installed is anticipated to be no greater than 2 feet. Dewatering or other methods of ground improvement will be required for shaft construction, because the presence of groundwater and variable geologic conditions would likely result in flowing or fast raveling conditions. Soldier piles,

sheet piles, and other shoring elements are expected to be able to be constructed using driving or vibration techniques. Obstructions such as boulders or debris are not expected.

Tunnel Excavation and Support Methods

Tunneling in soil (soft ground) involves excavating an underground opening by hand or by mechanical means, and stabilizing the opening with initial support, within which the final lining is built, resulting in a two-pass lining system. The final lining could be cast-in-place reinforced concrete or fabricated pipe made of precast concrete, steel, fiberglass, or other material. Tunneling in soft ground could also be performed using a one-pass lining system. In this case, the initial support system consisting of bolted gasketed precast concrete segments would also serve as the final lining. For this project, one-pass methods of construction were considered to be most feasible, due to the presence of saturated ground conditions, the length of the project, and the diameter of the storm sewer.

Conditions along the various tunnel alignments permit the use of several tunneling techniques. The project was designed to consist of a tunnel requiring only one Access Shaft and one Exit Shaft along each alignment. While soil conditions alone are conducive to microtunneling, this technique requires intermediate excavations for jacking and receiving shafts. It was not considered feasible or desirable to permit construction methods that will disrupt traffic with these intermediate shafts over the majority of the project.

Tunnel Excavation

Ground conditions along the proposed alignments consist of saturated cohesive and non-cohesive (granular) soils. Tunneling in non-cohesive soils located below the groundwater table requires special tunneling methods to control ground behavior, so that excessive ground loss is not experienced during tunnel excavation. It is important to select tunnel excavation and lining methods that are compatible with the saturated, non-cohesive soils. The primary tunnel excavation method used in these ground conditions is a positive face pressure tunnel boring machine such as an earth pressure balance (EPBM) or slurry TBM. Tunneling using compressed air to control the ground is a feasible method, but is no longer commonly used since the introduction of EPBM and slurry TBM technology. Of the two positive face pressure TBMs, the EPBM is the type most commonly used in the United States today.

The EPBM works by applying a pressure at the tunnel face that is slightly above the pressure induced at the face by in situ soil and groundwater. The EPBM develops this positive pressure in two ways, first by the forward thrust of the machine and secondly by controlling the quantity of muck (excavated soil) that is removed from the muck chamber. The muck chamber is a sealed compartment located directly behind the EPBM cutterhead. If the soil entering the muck chamber does not contain enough fine-grained material, the soil can be modified by adding bentonite slurry, foam, or other additives at the face and/or in the muck chamber to provide some cohesion to the soil. This cohesion allows a soil plug to form in the muck chamber, which is necessary to control face pressure. Muck is removed from the muck chamber via a screw conveyor, which is used to control the rate of muck removal and therefore pressure on the face. Once the muck has moved through the screw conveyor, it is transferred to a belt conveyor for transport out of the tunnel.

As an alternative to EPBM tunneling, tunnel excavation could be performed using a slurry TBM. This machine is more sophisticated than an EPBM, and allows for regulation of the pressure at the face to be more closely monitored. As a result, projects using slurry TBMs in Europe and Japan have been very successful in limiting ground movement and settlement. If a slurry TBM were to be used for this project, ground improvement measures as described in the EPBM section of this letter would not be required. Slurry TBMs have been used extensively and successfully in Europe and Asia, but only one project is currently underway in North America. Before selection of this type of machine for this project, Mn/DOT would need to decide if they are comfortable pioneering this method in the United States.

Tunnel Initial Support

The most common type of tunnel lining system used with an EPBM is a precast concrete bolted gasketed segmental system. A doweled gasketed segmental system is starting to be used in the United States; however, its use is not currently widespread. The system typically consists of five concrete segments and a key segment that are erected to form a circular compression ring. The segments are typically 4-foot long, resulting in a tunnel construction cycle that occurs in 4-foot increments.

The tunnel excavation and liner erection cycle is carried out in the following manner. The EPBM excavates approximately 4 ft of tunnel. The machine develops its forward thrust by pushing off the most recently installed segment ring. Excavation is stopped, and the segment ring is erected within the tail shield of the EPBM. While working within the tail shield, the ground surrounding the shield is supported and the workers erecting the segments are protected. Once the ring is completely erected, the excavation cycle is restarted for another 4-foot "push."

The annulus between the excavated ground and the outside face of the segment ring is backfill grouted as excavation continues. The backfill grout can be injected through grout ports integral to the EPBM tail shield, or through grout ports cast into the segments during the manufacturing process. Tunnel excavation and segment erection should not be performed more than one to two segment rings ahead of backfilling operation. Once properly installed and backfilled, the bolted gasketed segmental concrete lining system should provide a water tight tunnel lining.

Shaft Excavation and Support

All of the required shafts for the project will be constructed entirely within soil. Localized dewatering will necessary at the shaft excavations, as they are anticipated to be located below the groundwater table. The soils present at the shafts are expected to be well-suited to excavation using traditional shaft excavation techniques such as a loader or clamshell.

Based upon the ground conditions along the project, shaft support methods considered viable for this project include Soldier Piles and Lagging, Circular Ring Beams and Lagging, Interlocking Steel Sheet Piles, Slurry Walls, and Steel Liner Plates.

Section 7

Estimated Project Costs

Cost summaries for various alternatives are presented below. Some of the assumptions used in the development of these costs are outlined below.

- Access shafts to Tunnel Alternatives will occur at no greater than 1000' intervals
- Two shaft holes are required for each tunnel option
- Two work sites are required for each tunnel option
- One Portal site is required for each tunnel option
- All existing storm sewer will need to be lined at the start of the project, and at Year 40
- At Year 40, 50% of all retaining walls will need to be reconstructed
- At Year 40, a portion of the storage cells will need to be reconstructed with a cost equivalent to 25% of the initial construction cost
- At Year 40, replace force main
- At Year 40, upgrade 50% of pump station
- At Year 40, 25% of structural concrete will need to be replaced
- For midlife reconstruction, assume the SLC equals 0.21%
- To calculate demolition costs for apartments, the cubic feet of living space per residence is assumed to be 1500 square feet times 15 feet of structure height.
- Acquisition Factor (to reflect the actual cost of land) equals 2.00
- Four tunnel construction access shafts will be constructed outside of the right-

of-way (the balance will be constructed within the right-of-way). The location of these shafts is undetermined, but it is assumed that roadway adjacent parking lots can be leased, used and repaved at $200,000 each.

Table 7-1 Quantitative Comparison (80 Year Life Cycle Cost) – 2007 Dollars

	Engineering and Design	Property Acquisition	Construction	Construction Management	Maintenance	Total
1C – Tunnel w/ D/S Detention	$16,870,000	$920,000	$140,610,000	$7,030,000	$580,000	$166,010,000
2C – Existing Sewer w/ Modified Adjacent Ponding	$5,590,000	$150,750,000	$46,550,000	$2,330,000	$970,000	$206,190,000
2D – Existing Sewer w/ Buried Ponding Under Highway	$18,200,000	$000	$151,660,000	$7,580,000	$720,000	$178,160,000
2E – Existing Sewer w/ Modified Adjacent and Under Roadway Ponding	$9,270,000	$41,470,000	$77,270,000	$3,860,000	$720,000	$132,590,000
2F – Existing Sewer w/ Buried Ponding, Sealed or Lowered Groundwater	$8,010,000	$10,000	$66,750,000	$3,340,000	$720,000	$78,830,000
4A – Tunnel along I-35W w/ D/S Detention	$18,190,000	$920,000	$151,620,000	$7,580,000	$580,000	$178,890,000
5A – Storage Tunnel w/Gravity Outfall	$12,050,000	$920,000	$100,390,000	$5,020,000	$1,360,000	$119,740,000

Source: Stanley Consultants, Inc.

I-494 STORMWATER ALTERNATIVES STUDY

PROPERTY ACQUISITION COSTS

4/26/2007

Alternative	Address	Owner	Current Usage	Market Value	Parcel Area	Acquisition Cost	Easement Cost	2007 Property Tax, Net	Present Value of Loss of Tax Base	Affected Tenants, No.	Relocation Cost	Affected Building Area	Affected Building Height	Affected Building Volume	Pavement Removal Area	Demolition Cost	Parcel Cost
1C			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
1C			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
1C			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
1C			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
1C			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
1C			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
1C			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
1C			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
1C						$ -	$ 800,000		$ 12,298		$ -					$ 112,000	$ 924,298
2C	7800 Penn Ave S	TCF Bank	Commercial	$ 2,894,300.00	135000	$ 5,789,000	$ -	$ 90,842.65	$ 1,393,399.70	1	$ 200,000.00	12000	30	360000	67000	$ 148,000.00	$ 7,530,399.70
2C	7801 Nicollet Ave S	A G Bogen Company	Commercial	$ 4,329,500.00	230000	$ 8,659,000	$ -	$ 135,520.72	$ 2,083,285.63	1	$ 200,000.00	43000	45	1935000	140000	$ 665,000.00	$ 11,607,285.63
2C	7701 Portland Ave S	Asian Direct Oriental Mkt Inc	Commercial	$ 735,000.00	22000	$ 1,470,000	$ -	$ 22,892.60	$ 351,915.37	1	$ 200,000.00	8000	15	120000	14000	$ 44,000.00	$ 2,065,915.37
2C	631 - 77 St E	Carole Boyum	Apartment	$ 1,152,000.00	41000	$ 2,304,000	$ -	$ 16,549.37	$ 254,404.38	9	$ 180,000.00	6500	30	195000	6500	$ 62,000.00	$ 2,800,404.38
2C	7727 Portland Ave S	Homes RE 1	Nursing Home	$ 1,521,000.00	29000	$ 3,042,000	$ -	$ 21,850.86	$ 335,901.28	15	$ 300,000.00	11000	30	330000	5100	$ 102,000.00	$ 3,779,901.28
2C	7733 Portland Ave S	Sinclaire Marketing	Commercial	$ 741,000.00	27000	$ 1,482,000	$ -	$ 23,089.18	$ 354,937.29	1	$ 200,000.00	4000	15	60000	23000	$ 32,000.00	$ 2,068,937.29
2C	616 - 78th St E	Lois Berg	Commercial	$ 605,000.00	26000	$ 1,210,000	$ -	$ 18,634.62	$ 286,459.78	1	$ 200,000.00	2700	15	41000	15800	$ 22,000.00	$ 1,718,459.78
2C	620 - 78th St E	Richfield Apartments Center	Apartment	$ 3,725,000.00	91000	$ 7,450,000	$ -	$ 53,513.03	$ 822,626.43	48	$ 960,000.00	24000	45	1080000	36600	$ 346,000.00	$ 9,578,626.43
2C	701 - 77th St E	Richfield Apartments Center	Apartment	$ 4,451,000.00	124000	$ 8,902,000	$ -	$ 63,942.57	$ 982,954.03	63	$ 1,260,000.00	31400	45	1413000	80200	$ 472,000.00	$ 11,616,954.03
2C	710 - 78th st E	Richfield Apartments Center	Apartment	$ 3,725,000.00	117000	$ 7,450,000	$ -	$ 53,513.03	$ 822,626.43	62	$ 1,240,000.00	31000	45	1395000	74300	$ 463,000.00	$ 9,975,626.43
2C	1550 - 78th St E	Olin-Mathwig	Commercial	$ 4,256,000.00	130000	$ 8,512,000	$ -	$ 138,218.37	$ 2,124,755.12	3	$ 600,000.00	26000	45	1170000	68000	$ 392,000.00	$ 11,628,755.12
2C	1600 - 78th ST E	DIVISION IN PROGRESS	Commercial	$ 100.00	28000	$ -	$ -	$ 100.00	$ 1,537.25	1	$ 200,000.00	6100	15	92000	8900	$ 33,000.00	$ 234,537.25
2C	1620 - 78TH St E	Jerry Mathwig	Commercial	$ 1,525,000.00	76000	$ 3,050,000	$ -	$ 48,768.10	$ 749,685.23	1	$ 200,000.00	18000	15	270000	38000	$ 104,000.00	$ 4,103,685.23
2C	1640 - 78th St E	Jerry Mathwig	Commercial	$ 1,140,000.00	88000	$ 2,280,000	$ -	$ 37,339.20	$ 573,995.02	1	$ 200,000.00	7500	15	113000	19000	$ 45,000.00	$ 3,098,995.02
2C	1918 American Blvd E	Columbia Properties	Commercial	$ 14,049,200.00	291000	$ 28,098,000	$ -	$ 442,322.26	$ 6,799,577.28	1	$ 200,000.00	85000	45	3825000	164000	$ 1,246,000.00	$ 36,343,577.28
2C	2008 American Blvd E	Columbia Properties	Commercial	$ 7,819,000.00	64000	$ 15,638,000	$ -	$ 246,805.94	$ 3,794,012.23	0	$ -	33000	45	1485000	24600	$ 460,000.00	$ 19,892,012.23
2C	2020 American Blvd E	Columbia Properties	Commercial	$ 5,083,000.00	139000	$ 10,166,000	$ -	$ 160,444.33	$ 2,466,422.61	0	$ -	0	0	0	125100	$ 75,000.00	$ 12,707,422.61
2C						$ 115,502,000	$ -		$ 24,198,495		$ 6,340,000					$ 4,711,000	$ 150,751,495
2D				$ 100.00	100000	$ -	$ -	$ 100.00	$ 1,537.25		$ -			0		$ -	$ 1,537.25
2D				$ 100.00	100000	$ -	$ -	$ 100.00	$ 1,537.25		$ -			0		$ -	$ 1,537.25
2D						$ -	$ -		$ 3,074		$ -					$ -	$ 3,074
2E	7717 Pillsbury Ave S	Robert George	Industrial	$ 224,000.00	106000	$ 448,000	$ -	$ 6,155.51	$ 94,625.28	1	$ 200,000.00	20000	15	300000	86000	$ 142,000.00	$ 884,625.28
2E	7639 Portland Ave S	VSA	Commercial	$ 3,977,700.00	175000	$ 7,955,000	$ -	$ 124,416.23	$ 1,912,582.40	6	$ 1,200,000.00	50000	15	750000	125000	$ 300,000.00	$ 11,367,582.40
2E	7701 Portland Ave S	Asian Direct Oriental Mkt Inc	Commercial	$ 735,000.00	22000	$ 1,470,000	$ -	$ 22,892.60	$ 351,915.37	1	$ 200,000.00	8000	15	120000	14000	$ 44,000.00	$ 2,065,915.37
2E	631 - 77 St E	Carole Boyum	Apartment	$ 1,152,000.00	41000	$ 2,304,000	$ -	$ 16,549.37	$ 254,404.38	9	$ 180,000.00	6500	30	195000	6500	$ 62,000.00	$ 2,800,404.38
2E	7727 Portland Ave S	Homes RE 1	Nursing Home	$ 1,521,000.00	29000	$ 3,042,000	$ -	$ 21,850.86	$ 335,901.28	15	$ 300,000.00	11000	30	330000	5100	$ 102,000.00	$ 3,779,901.28
2E	7733 Portland Ave S	Sinclaire Marketing	Commercial	$ 741,000.00	27000	$ 1,482,000	$ -	$ 23,089.18	$ 354,937.29	1	$ 200,000.00	4000	15	60000	23000	$ 32,000.00	$ 2,068,937.29
2E	616 - 78th St E	Lois Berg	Commercial	$ 605,000.00	26000	$ 1,210,000	$ -	$ 18,634.62	$ 286,459.78	1	$ 200,000.00	2700	15	41000	15800	$ 22,000.00	$ 1,718,459.78
2E	620 - 78th St E	Richfield Apartments Center	Apartment	$ 3,725,000.00	91000	$ 7,450,000	$ -	$ 53,513.03	$ 822,626.43	48	$ 960,000.00	24000	45	1080000	36600	$ 346,000.00	$ 9,578,626.43
2E	1620 - 78TH St E	Jerry Mathwig	Commercial	$ 1,525,000.00	76000	$ 3,050,000	$ -	$ 48,768.10	$ 749,685.23	1	$ 200,000.00	18000	15	270000	38000	$ 104,000.00	$ 4,103,685.23
2E	1640 - 78th St E	Jerry Mathwig	Commercial	$ 1,140,000.00	88000	$ 2,280,000	$ -	$ 37,339.20	$ 573,995.02	1	$ 200,000.00	7500	15	113000	19000	$ 45,000.00	$ 3,098,995.02
2E						$ 30,691,000	$ -		$ 5,737,132		$ 3,840,000					$ 1,199,000	$ 41,467,132
2F				$ 100.00	100000	$ -	$ -	$ 100.00	$ 1,537.25		$ -			0		$ -	$ 1,537.25
2F				$ 100.00	100000	$ -	$ -	$ 100.00	$ 1,537.25		$ -			0		$ -	$ 1,537.25
2F				$ 100.00	100000	$ -	$ -	$ 100.00	$ 1,537.25		$ -			0		$ -	$ 1,537.25
2F				$ 100.00	100000	$ -	$ -	$ 100.00	$ 1,537.25		$ -			0		$ -	$ 1,537.25
2F				$ 100.00	100000	$ -	$ -	$ 100.00	$ 1,537.25		$ -			0		$ -	$ 1,537.25
2F				$ 100.00	100000	$ -	$ -	$ 100.00	$ 1,537.25		$ -			0		$ -	$ 1,537.25
2F				$ 100.00	100000	$ -	$ -	$ 100.00	$ 1,537.25		$ -			0		$ -	$ 1,537.25
2F				$ 100.00	100000	$ -	$ -	$ 100.00	$ 1,537.25		$ -			0		$ -	$ 1,537.25
2F				$ 100.00	100000	$ -	$ -	$ 100.00	$ 1,537.25		$ -			0		$ -	$ 1,537.25
2F						$ -	$ -		$ 13,835		$ -					$ -	$ 13,835
4A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
4A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
4A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
4A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
4A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
4A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
4A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
4A						$ -	$ 800,000		$ 12,298		$ -					$ 112,000	$ 924,298
5A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
5A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
5A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
5A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
5A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
5A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
5A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
5A			Parking Lot	$ 200,000.00	225000	$ -	$ 100,000	$ 100.00	$ 1,537.25	0	$ -	0	0	0	22500	$ 14,000.00	$ 115,537.25
5A						$ -	$ 800,000		$ 12,298		$ -					$ 112,000	$ 924,298
Alternative	Address	Owner	Current Usage	Market Value	Parcel Area	Acquisition Cost	Easement Cost	2007 Property Tax, Net	Present Value of Loss of Tax Base	Affected Tenants, No.	Relocation Cost	Affected Building Area	Affected Building Height	Affected Building Volume	Pavement Removal Area	Demolition Cost	Parcel Cost

Appendix A

Alternative 1C – Conveyance Tunnel

Outfall Location

The tunnel outfall is to a water quality pond to be expanded at the West Pond site, under the I-494 bridge over the Minnesota River. The Almaz Pond outfall, located just north of I-494 on the Minnesota River, will continue as the outfall for the re-used portion of the existing drainage system. The outfalls are located within the Lower Minnesota River Watershed District (LMRWD).

Conveyance System

Under Alternative 1C, stormwater would be conveyed through a 10-foot diameter, concrete-lined tunnel from Penn Avenue to the east. The tunnel can be constructed to such a depth as to allow for future expansion to the west.[1] Water quality detention storage for sediment and phosphorus removal would be provided in a reconstructed West Pond at the tunnel outfall to the Minnesota River (as well as in the existing Almaz Pond). The tunnel is 5.1 miles (26,900 feet) long. The slope of the tunnel is 0.12% from Penn Avenue to Wentworth Avenue and increases to 0.20% from there to TH 77, where it increases to 0.49 percent to the outfall at West Pond.

Low points in the I-494 alignment that contribute drainage to the tunnel include Penn, Wentworth, Portland, 12th and Cedar (TH 77) Avenues. In Alternative 1C, the existing trunk storm sewer is abandoned from Colfax Avenue South to 12th Avenue South. Drop shafts are located at the Penn Avenue, Wentworth, Portland Avenue and TH 77 low points. The system XP-SWMM model includes a surface collection system between Colfax and Nicollet to bring stormwater to the Wentworth low point. From 12th Avenue to the river, the existing drainage system is utilized, with a drop shaft at TH 77 to drop flow from the 12th Avenue and TH 77 low points into the tunnel. The four drop shafts would be vortex-flow type which allow air removal

[1] While the tunnel could be extended as far as US 169, there has been no present or future need for such an expansion identified.

through a central air core in the shaft. The drop shafts, sized for the 100-year event, were dimensioned according to Jain and Kennedy (1983):

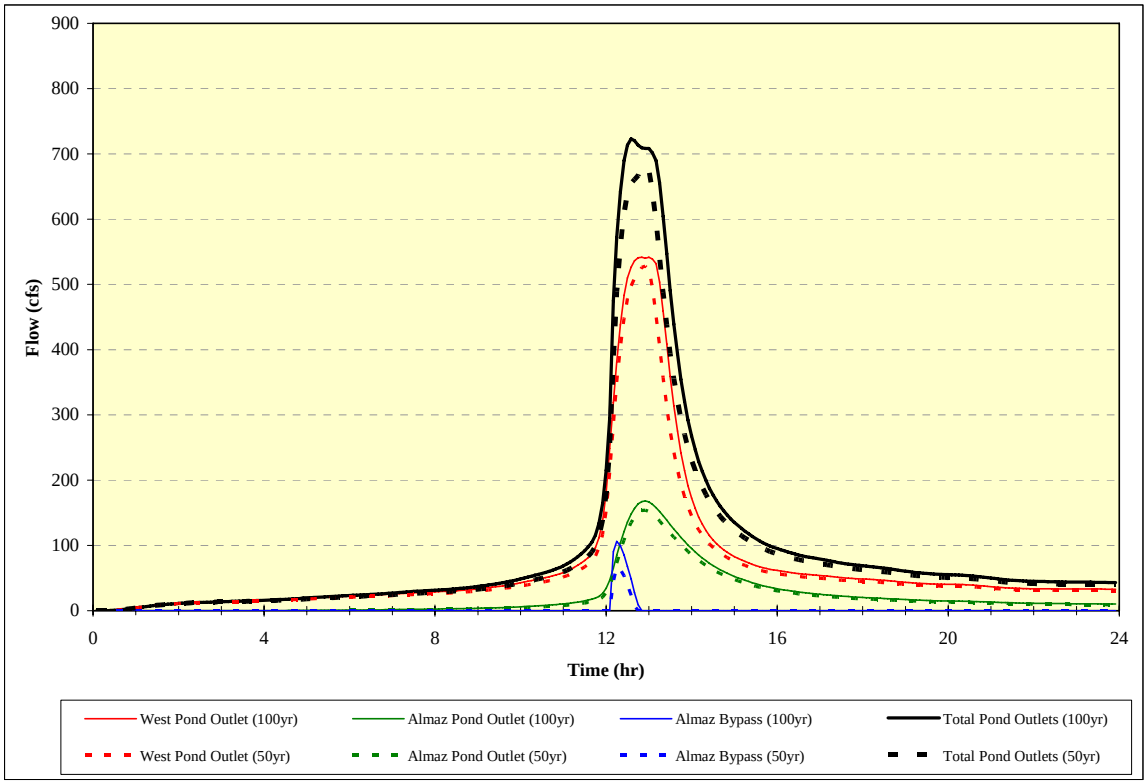
Table A-1

	Penn	Wentworth	Portland	TH 77
100-year Discharge to Drop Shaft [cfs]	100	270	400	510
Vortex Drop Shaft Diameter [ft]	4.0	7.0	7.0	7.0
Highway Profile Elevation [ft msl]	821	815	810	813
Tunnel Invert Elevation [ft msl]	791.9	783.3	776.3	765.7
Drop Shaft Depth from Highway Profile [ft]	29	32	34	47

The West Pond outlet to the Minnesota River was modeled as a 100-ft weir which resulted in a 1.5-ft bounce during the 100-year event. The weir was enlarged to minimize unintentional storage since the soils on the site are not adequate for the construction of berms. Detail design would address the exact outlet configuration with consideration for the effects of the discharge velocity on navigation and channel stability on the Minnesota River. See Appendix H for concerns raised about the outfall by the Lower Minnesota River Watershed District.

Rate Control

Rate control is not included in Alternative 1C. Wenck (2007b; Appendix H) demonstrated that inclusion of rate control would not benefit the Minnesota River in terms of peak discharge rate or peak flood stage, due to the relative timing of peak discharges from the I-494 corridor and those on the Minnesota River. This information was presented to the LMRWD Board of Managers who passed a resolution (Appendix H) that agreed in concept that Alternative 1C could be constructed without rate control. The Board of Managers raised several concerns about the outfall to the river which would best be addressed in final design. The Alternative 1C discharge to the Minnesota River is visualized in Figure A-1 below.



Individual Outfall, and Combined Hydrographs for Alternative 1C Discharge to the Minnesota River

Figure A-1

Water Quality

In Alternative 1C, the 52 acre-feet of runoff from the 2.5-inch rainfall event would be split between the West Pond (approximately 38 acre-feet) and Almaz Pond (about 14 acre-feet). The Almaz Pond volume 19 acre-feet is somewhat oversized and exceeds water quality requirements with 54 percent phosphorus removal. By sizing the West Pond water quality (dead) volume at 34 acre-feet, its removal rate is 49 percent and the combined removal is 50 percent. With depth of six feet and a 10-ft safety bench, the area of West Pond at normal water level would be 6.2 acres.

Sediment

Sediment from the I-494 drainage system would collect in Almaz and West Ponds, roughly in proportion to the flow volume. The total suspended sediment load for the I-494 drainage system is estimated as 400,000 lb/yr; this represents a total volume of roughly 5,000 ft^3/yr, or 2.3 ac-ft over a twenty–year period. (This is based on a typical total suspended solids concentration of 300 mg/L, and equivalent to about 900 lb/acre.) The sediment accumulation in Almaz Pond and in West Pond would reach about 0.6 and 1.7 acre-feet, respectively after 20 years of operation; these volumes correspond to average depths of sediment of 0.2 feet and 0.3 feet, respectively.

Maintenance

As per the sedimentation discussion in Section 3, even though Mn/DOT does not use sand for snow and ice control along this section of highway, the accumulation of sediment still occurs. This material finds its way to the site on the tires of vehicles entering from sandy areas, as wind blown debris from off site, or from open topped loads of sand and aggregate that traverse the highway.

Regardless of the drainage Alternative selected, the total amount of sediment generated over the 438 acre site will remain constant. This is estimated at 4,468 cubic feet of material each year. Although a consistent street sweeping program can capture half of this material, our estimates assume that all suspended solids are conveyed to the storm sewer system.

For Alternative 1C, the entire load conveyed within the tunnel will be transported to West Pond. As the existing storm sewer system downstream of TH 77 will be utilized, a portion of the total load will be deposited in Almaz Pond (see Sediment section above).

Our assumption is that both Almaz and West Ponds will be cleaned of accumulated sediment every ten years. As with other existing detention basins, cleaning will occur during the winter, when water levels are low and access by tracked excavators and dump trucks can be made over frozen ground. Although it is anticipated that all sediment will be conveyed to the ponds, our costs estimate also includes regular cleaning of system catch basins.

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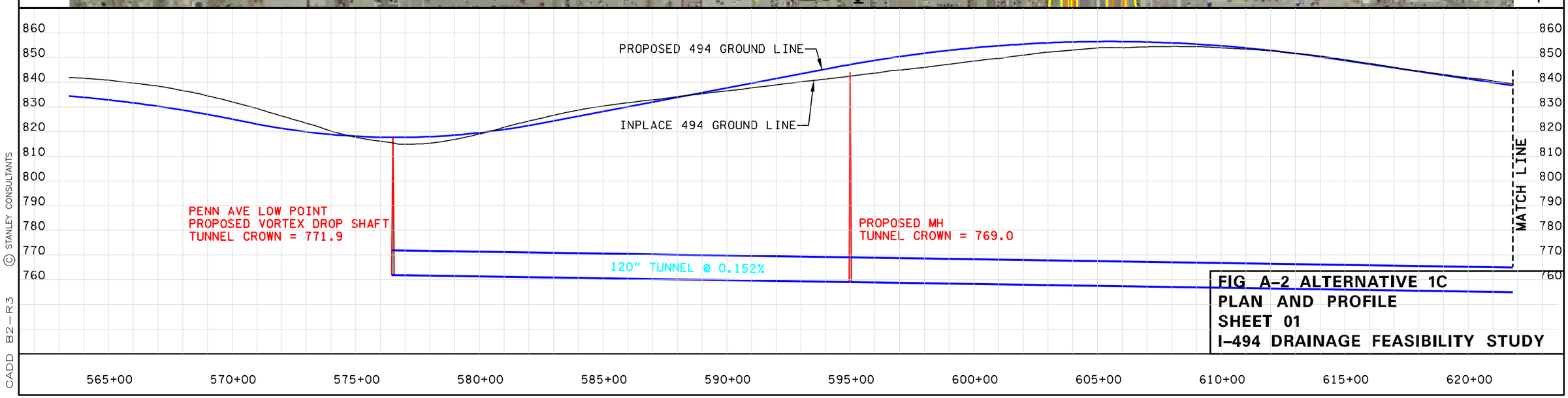

FIG A-2 ALTERNATIVE 1C
PLAN AND PROFILE
SHEET 01
I-494 DRAINAGE FEASIBILITY STUDY

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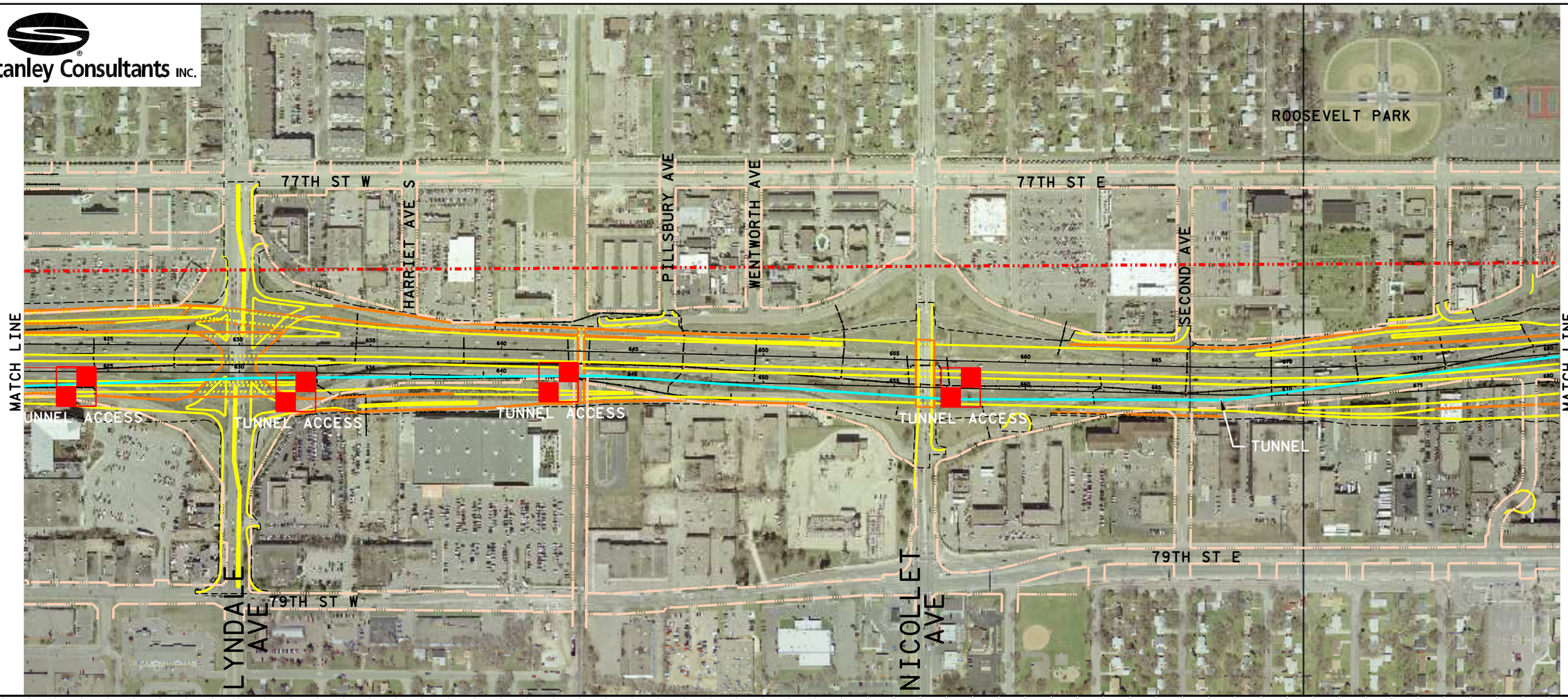
CADD B2-R3

Stanley Consultants INC.



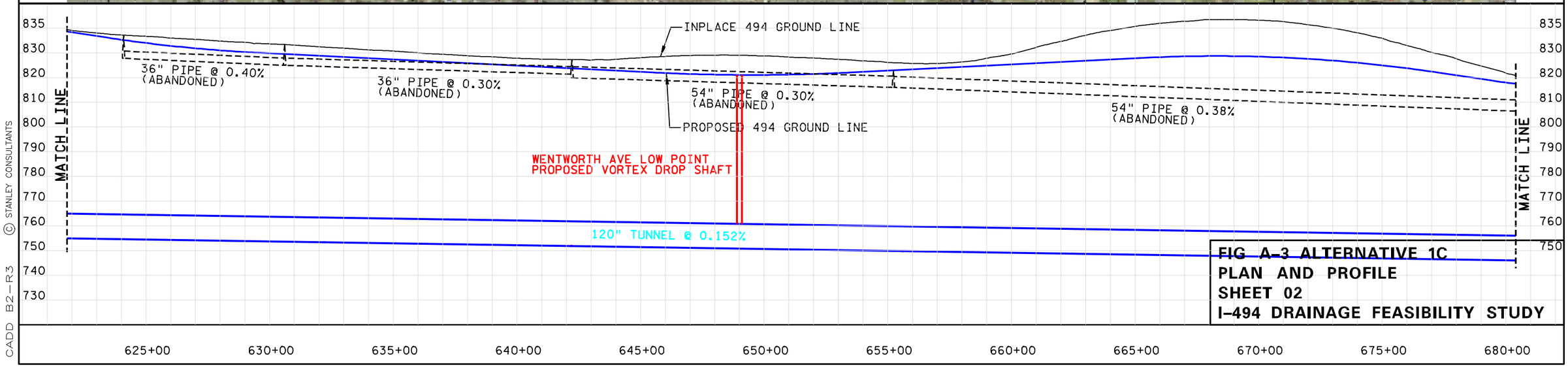


FIG A-3 ALTERNATIVE 1C
PLAN AND PROFILE
SHEET 02
I-494 DRAINAGE FEASIBILITY STUDY

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CADD B2-R3

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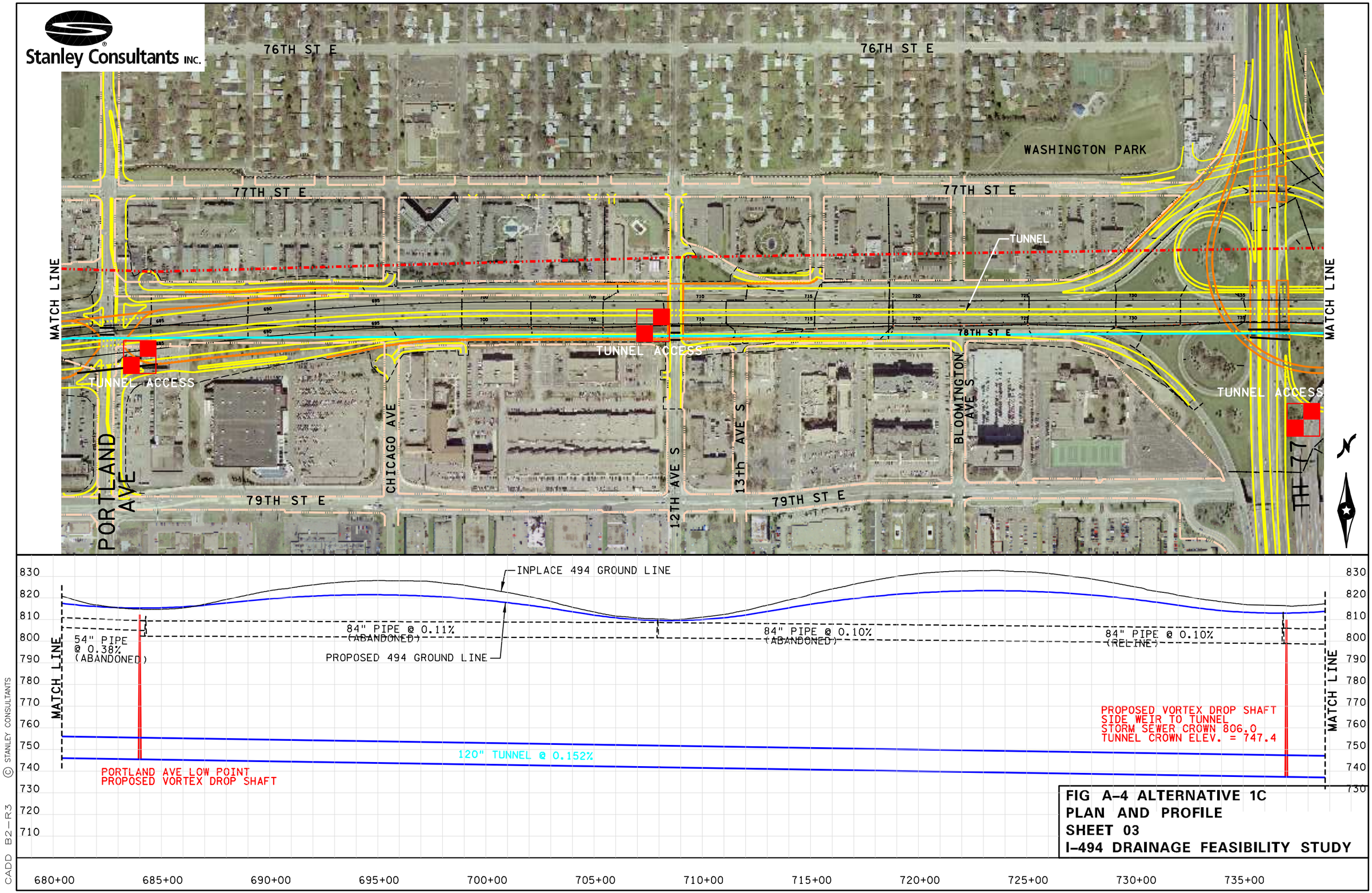

FIG A-4 ALTERNATIVE 1C
PLAN AND PROFILE
SHEET 03
I-494 DRAINAGE FEASIBILITY STUDY

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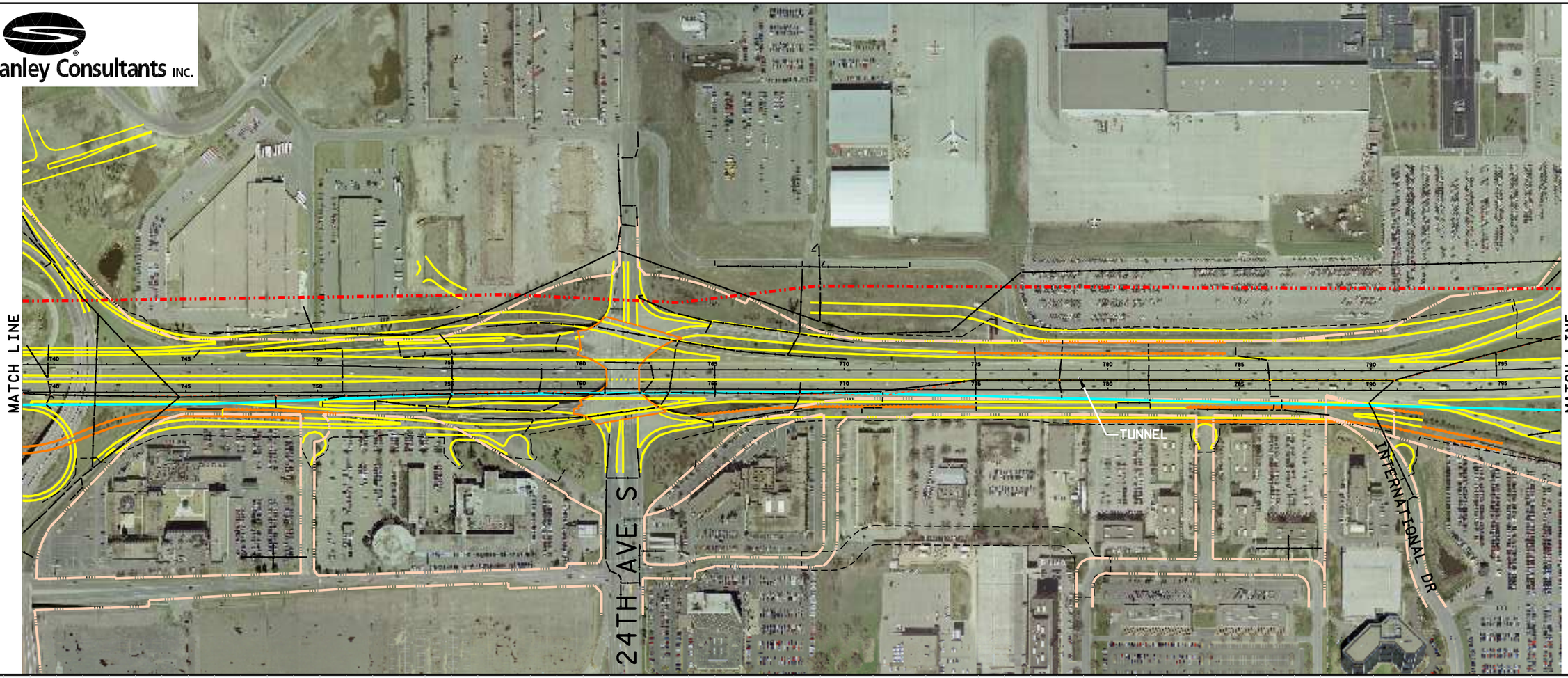

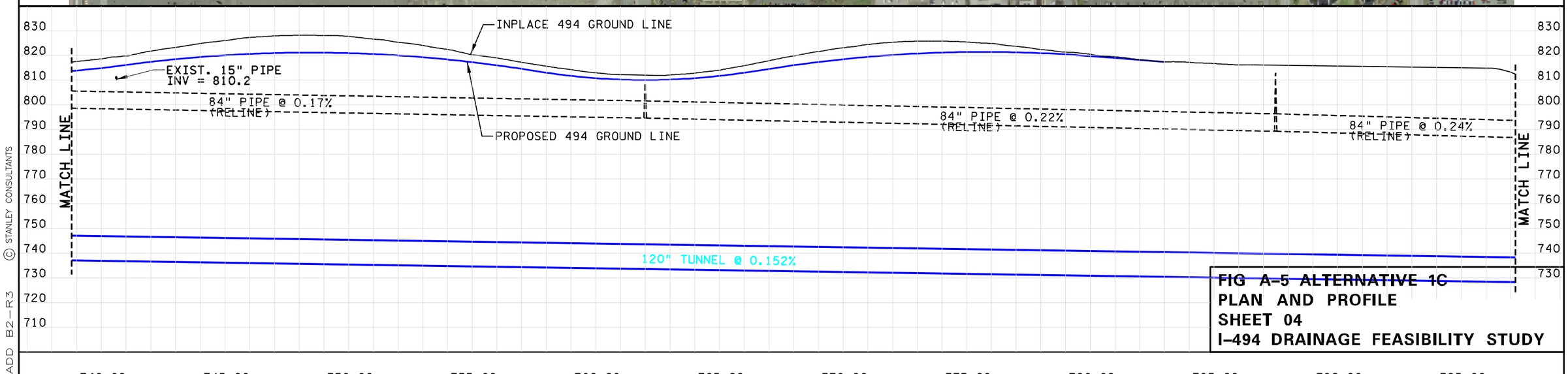

FIG A-5 ALTERNATIVE 1C
PLAN AND PROFILE
SHEET 04
I-494 DRAINAGE FEASIBILITY STUDY

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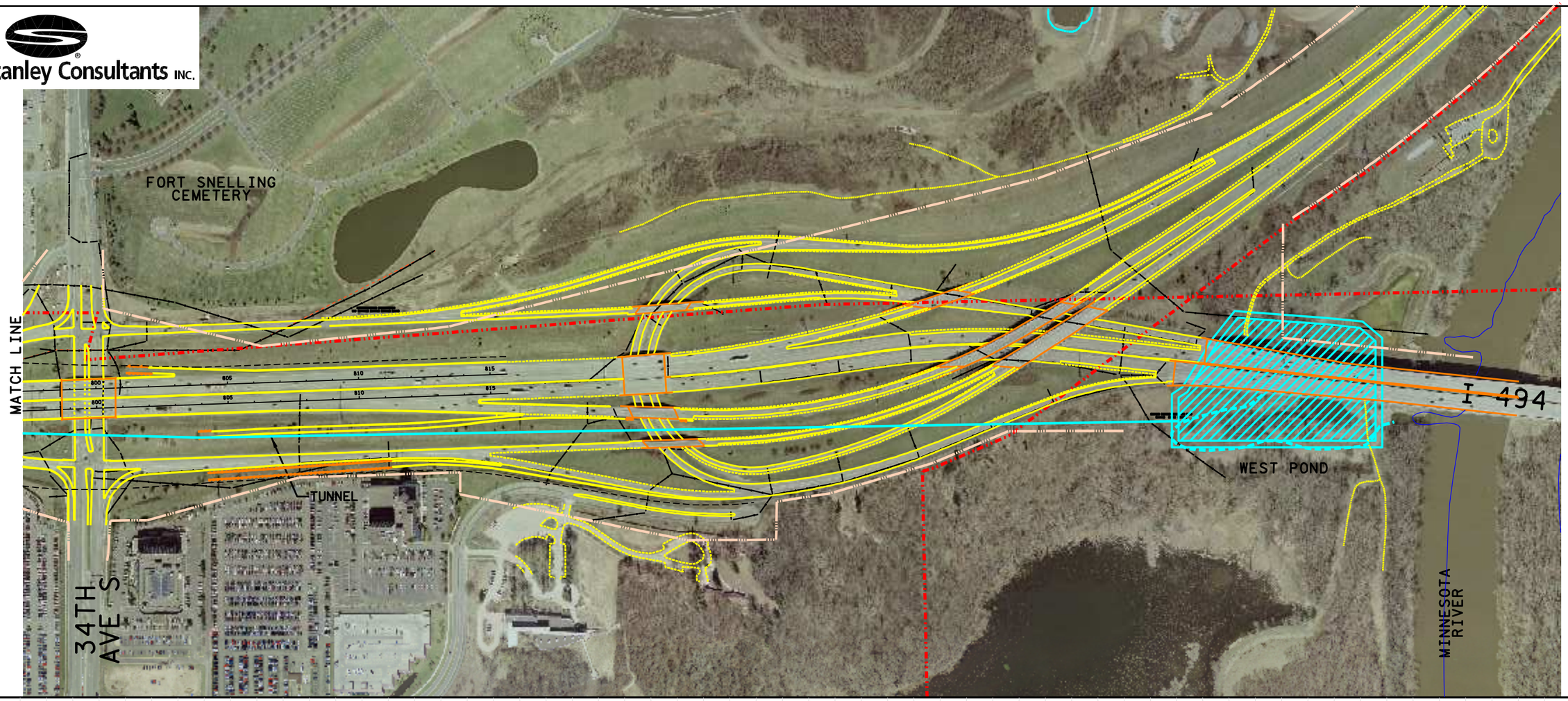
CADD B2-R3

Stanley Consultants INC.



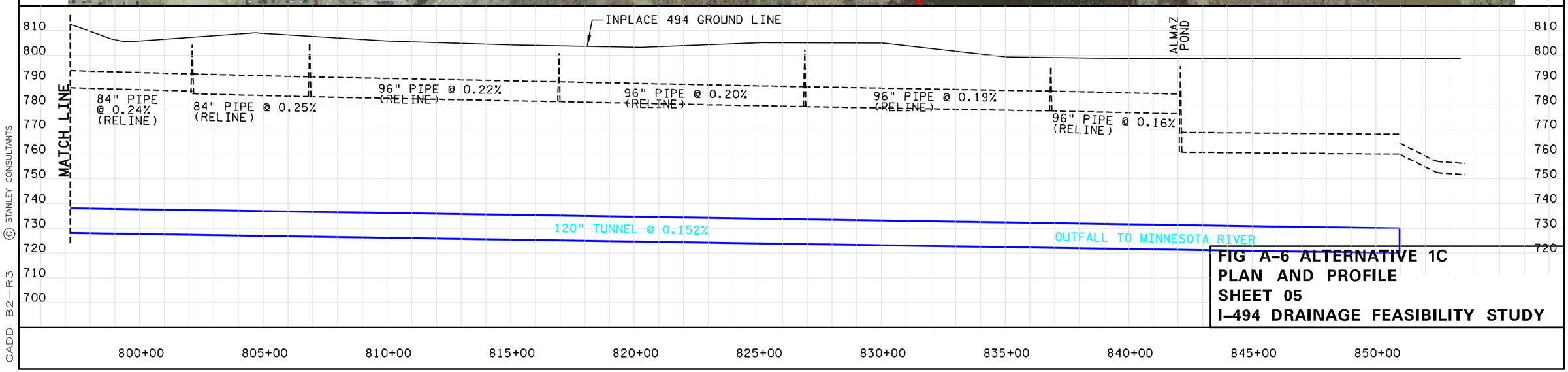


FIG A-6 ALTERNATIVE 1C
PLAN AND PROFILE
SHEET 05
I-494 DRAINAGE FEASIBILITY STUDY

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CADD B2-R3

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 1C	**Conveyance Tunnel**	Lower MN Watershed permit required				x	
	Construct new 120" conveyance tunnel from Penn Avenue to West Pond.	Volume reduction on municipal boundary basis[1]			x	x	
		Less land needed			x		x
		Improved water quality and sediment removal[2]			x	x	
		West pond can handle the water					x
	Detention & water quality in newly configured West pond and Almaz	Provides some rate control				x	
		MAC received okay to discharge to the river at a higher rate[3]				x	
	Potential for expansion west of Penn Avenue	May be cheaper since no need to acquire land[6]	x	x			x
	Upstream sediment collection	Logical area for buried storage		x			
	Outfall at West Pond and Almaz Pond	Eliminate pump at Penn Ave.[4]	x	x			x
		Various maintenance possibilities[5]		x			
		Locally much easier	x	x			
		Volume (rate control) is a problem[17]				x	
		Richfield would not invest in a cost share option on a percentage basis		x			
		Phosphorus removal still needed[11]				x	x
		Limited large scale storage examples[15]	x	x	x		x
		Minimal effect on river or adjacent properties[12]					x
		Storage concerns[13]	x			x	x
		Maintenance concerns[14]	x				x
		Expensive	x	x			x
		Potential for additional storage at West Pond					x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION	STAKEHOLDER CONCERNS	
	This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington Richfield Nine Mile Lower MN Mn/DOT

Notes:

1. Water could still be taken down to the river and treated at those ponds.
2. Met water quality standard.
3. Based on the same information as Mn/DOT.
4. The pumps would go into the new system and would not need to be programmed on a hydrograph schedule.
5. These possibilities include: remote control vehicles, future technology, better street sweeping to prevent build up of sediment in the tunnel, and stormcepters.
6. This is already an expensive project. Even if the tunnel ends up costing more, it may be worth the extra expense to avoid having to acquire more land.
7. The City of Bloomington has a much shorter timeframe than Mn/DOT, and needs to provide funding
8. Massive political problems (Richfield's land use plan is already done).
9. This space is located in Bloomington by 24th and I-494 by the airport.
10. Because of all the current construction in these areas, the Cities need to know what land the ponds will be built on so they can to help protect this land.
11. It is needed for longer term detention downstream.
12. This assumes peak flow is allowed without detention.
13. Sediment may get into the tunnel and than it will need to be removed.
14. The tunnel is more difficult to clean out then the surface ponds.
15. Maintenance costs and techniques for buried storage of this magnitude are difficult to calculate because of the lack of existing comparable systems.
16. Not used.
17. Rate control standards are not met.
18. The ponds in Bloomington that are located below the bluff are currently not meeting capacity and need maintenance.
19. This includes land beyond the ROW.
20. This leads to flooding at the low points along the corridor.
21. Richfield would double the property cost listed on the Hennepin County Assessor's site.
22. The combination of cost and disruption to the Cities is very high.

CONCEPTUAL COST ESTIMATE
I-494 STORMWATER ALTERNATIVES STUDY

Apr-07

PRE-CONSTRUCTION - ENGINEERING AND DESIGN	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES - INITIAL CONSTRUCTION 1C	TOTAL ESTIMATED COST - INITIAL CONSTRUCTION 1C	TOTAL ESTIMATED QUANTITIES - RECONSTRUCTION 1C	TOTAL ESTIMATED COST - RECONSTRUCTION 1C
ENGINEERING AND DESIGN		VARIES	12.00%	$14,558,491.44	12.00%	$2,314,880.77		
Assume a set percentage of the construction cost, does right-of-way and acquisition								
				$14,558,491.44		$2,314,880.77		
RIGHT OF WAY and EASEMENTS	LUMP SUM	VARIES	$812,267.96	$0.00	$812,267.96	$0.00		
RELOCATION and RESTORE BENEFIT	LUMP SUM	VARIES	$0.00	$0.00	$0.00	$0.00		
PAVEMENT REMOVAL and DEMOLITION	LUMP SUM	VARIES	$112,000.00	$0.00	$112,000.00	$0.00		
				$924,267.96		$0.00		

PRE-CONSTRUCTION - RIGHT-OF-WAY	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
TUNNEL, 120" DIAMETER	LF	$1,000.00	0	$0.00	0	$0.00
TUNNEL, 144" DIAMETER	LF	$3,500.00	0	$0.00	0	$0.00
TUNNEL SHAFT HOLES	EACH	$285,000.00	2	$0.00	2	$0.00
PORTAL WORK SITE (with tunnel inlet/outlet only)	LUMP SUM	$115,000.00	28	$0.00	28	$0.00
DEWATERING	LF	$15,000.00	1	$0.00	1	$0.00
MICROTUNNEL, 42" DIAMETER	600' UNITS	$20,000.00	78	$0.00	78	$0.00
MICROTUNNEL ACCESS SHAFTS (every 600')	LF	$1,000.00	0	$0.00	0	$0.00
	EACH	$115,000.00	0	$0.00	0	$0.00
EROSE MAIN, 18" STEEL	LF	$50.00	0	$0.00	0	$0.00
CATCH BASIN (ADDITIONAL DEPTH OF DRAINAGE STRUCTURE)	LF	$380.00	700	$0.00	700	$0.00
RESURFACE TEMPORARY ACCESS LOCATIONS, 6"	SF	$2.00	180000	$0.00	180000	$0.00

CONSTRUCTION - PHYSICAL CONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
REHABILITATE STORM SEWER, 27" DIAMETER	LF	$220.00	601	$196,030.95	601	$196,030.95
REHABILITATE STORM SEWER, 36" DIAMETER	LF	$310.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 48" DIAMETER	LF	$420.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 60" DIAMETER	LF	$520.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 72" DIAMETER	LF	$620.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 84" DIAMETER	LF	$720.00	294450	$211,884,002.76	294450	$211,884,002.76
REHABILITATE STORM SEWER, 96" DIAMETER	LF	$820.00	2485	$1,456,365.87	2485	$1,456,365.87
POND LOCATION NUMBER 1, PENN AVENUE						
EXCAVATION	2105.515/0001C	CU.BIC YARD	0	$0.00	0	$0.00
TURF ESTABLISHMENT	ACRE	$9,000.00	0	$0.00	0	$0.00
PERIMETER FENCING	LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10H X 14W CONCRETE BOX CULVERT SECTIONS	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE LINER (To seal against groundwater infiltration)	LINEAR FOOT	$220.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	LINEAR FOOT	$250.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	CU.BIC YARD	$350.00	0	$0.00	0	$0.00
RETAINING WALL	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
POND LOCATION NUMBER 2, WENTWORTH AVENUE						
EXCAVATION	2105.515/0001C	CU.BIC YARD	0	$0.00	0	$0.00
TURF ESTABLISHMENT	ACRE	$9,000.00	0	$0.00	0	$0.00
PERIMETER FENCING	LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10H X 14W CONCRETE BOX CULVERT SECTIONS	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE LINER (To seal against groundwater infiltration)	LINEAR FOOT	$220.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	LINEAR FOOT	$250.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	CU.BIC YARD	$350.00	0	$0.00	0	$0.00
RETAINING WALL	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
POND LOCATION NUMBER 3, PORTLAND AVENUE						
EXCAVATION	2105.515/0001C	CU.BIC YARD	0	$0.00	0	$0.00
TURF ESTABLISHMENT	ACRE	$9,000.00	0	$0.00	0	$0.00
PERIMETER FENCING	LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10H X 14W CONCRETE BOX CULVERT SECTIONS	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE LINER (To seal against groundwater infiltration)	LINEAR FOOT	$220.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	LINEAR FOOT	$250.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	CU.BIC YARD	$350.00	0	$0.00	0	$0.00
RETAINING WALL	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
POND LOCATION NUMBER 4, TH 77						
EXCAVATION	2105.515/0001C	CU.BIC YARD	0	$0.00	0	$0.00
TURF ESTABLISHMENT	ACRE	$9,000.00	0	$0.00	0	$0.00
PERIMETER FENCING	LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10H X 14W CONCRETE BOX CULVERT SECTIONS	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE LINER (To seal against groundwater infiltration)	LINEAR FOOT	$220.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	LINEAR FOOT	$250.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	CU.BIC YARD	$350.00	0	$0.00	0	$0.00
RETAINING WALL	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
WEST POND EXPANSION (Or new pond for Alternative 4A)						
TURF ESTABLISHMENT	ACRE	$9,000.00	0.55	$4,950.00	0.55	$4,950.00
PERIMETER FENCING	LINEAR FOOT	$12.00	2200	$26,400.00	2200	$26,400.00
CONTROL STRUCTURE (Structural Concrete)	CU.BIC YARD	$350.00	150	$52,500.00	150	$52,500.00
RETAINING WALL	SQUARE FOOT	$35.00	6030	$211,050.00	6030	$211,050.00
PUMP STATION, 3.5 CFS	LUMP SUM	$100,000.00	0	$0.00	0	$0.00
SUBTOTAL				$212,884,002.76		$212,884,002.76
CONTINGENCY			20.00%	$42,576,800.55	20.00%	$42,576,800.55
				$255,460,803.31		$255,460,803.31

CONSTRUCTION - CONSTRUCTION MANAGEMENT	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
CONSTRUCTION MANAGEMENT		VARIES	6.00%	$14,558,491.44	6.00%	$14,558,491.44
Assume a set percentage of the construction cost, does right-of-way and acquisition						
				$14,558,491.44		$14,558,491.44

POST-CONSTRUCTION - MAINTENANCE	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
MAINTENANCE	LUMP SUM	$580,000.00	0	$0.00	0	$0.00
Present value of an annual sum						
				$580,000.00		$0.00

TOTAL PROJECT COST, INITIAL CONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES - YEAR 40	TOTAL ESTIMATED COST, PRESENT VALUE OF YEAR 40 CONSTRUCTION
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$2,314,880.77		$2,314,880.77
PRE-CONSTRUCTION - RIGHT-OF-WAY				$924,267.96		$0.00
PRE-CONSTRUCTION - PHYSICAL CONSTRUCTION				$121,320,762.00		$19,260,673.06
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$85,086,038.10		$3904,533.86
POST-CONSTRUCTION - MAINTENANCE				$580,000.00		$0.00
				$143,449,549.50		$22,570,087.48

TOTAL PROJECT COST, YEAR 40 RECONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$2,314,880.77
PRE-CONSTRUCTION - RIGHT-OF-WAY				$0.00
CONSTRUCTION - PHYSICAL CONSTRUCTION				$19,260,673.06
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$3904,533.86
POST-CONSTRUCTION - MAINTENANCE				$0.00
				$22,570,087.48

TOTAL PROJECT COST, 80-YEAR LIFE CYCLE, 2007 DOLLARS	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL PROJECT COST, 80-YEAR LIFE CYCLE, 2007 DOLLARS
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$16,872,372.21
PRE-CONSTRUCTION - RIGHT-OF-WAY				$924,267.96
CONSTRUCTION - PHYSICAL CONSTRUCTION				$149,611,435.09
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$7,039,974.76
POST-CONSTRUCTION - MAINTENANCE				$580,000.00
				$166,019,878.98

MAINTENANCE COSTS
I-494 STORMWATER ALTERNATIVES STUDY

ALTERNATIVE	1C	2C	2D	2E	2F	4A	5A
SEDIMENT ACCUMULATION	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)
PENN		3300	3300	3300	3300		
WENTWORTH		26500	2100	2100	2100		
PORTLAND		10000	1400	1400	1400		
TH 77		29100	3800	3800	3800		
ALMAZ POND	26100	31300	89600	89600	89600	74100	26100
WEST POND	74100	0	0	0	0	26100	74100
	100200	100200	100200	100200	100200	100200	100200
20-year volume [ac-ft]	2.30	2.30	2.30	2.30	2.30	2.30	2.30

SEDIMENT COLLECTION

Use upstream catch basins to collect sediment prior to entry into mainline storm sewer *

Number of Intakes, EA	175	175	175	175	175	175	525
Additional height per intake, FT	4	4	4	4	4	4	4
Assumed height of additional intakes, FT	700	700	700	700	700	700	2100
At 6' diameter, provided storage per unit, CF	113	113	113	113	113	113	113
Total Intake Storage Provided, CF	19775	19775	19775	19775	19775	19775	59325
Total Intake Storage Provided, CY	732	732	732	732	732	732	2197
Catch basin volume [ac-ft]	0.45	0.45	0.45	0.45	0.45	0.45	1.36

* Assume equivalent distribution over each ponding area

Sediment to be removed from sumps **

PENN		2475	2475	2475	2475		
WENTWORTH		19875	1575	1575	1575		
PORTLAND		7500	1050	1050	1050		
TH 77		21825	2850	2850	2850		
ALMAZ POND	19575	23475	67200	67200	67200	55575	19575
WEST POND	55575					19575	55575
20-year volume to Ponds	1.73	1.73	1.73	1.73	1.73	1.73	1.73
20-year volume to Catch Basins	0.58	0.58	0.58	0.58	0.58	0.58	0.58
20-year volume total	2.30	2.30	2.30	2.30	2.30	2.30	2.30

** Assume 25% of sediment is captured in the catch basins

Maintenance Assumptions

Catch Basins

20% Intakes cleaned annually
6,262.50 Sediment Cleaned Annually from sumps
6 Intakes per hour per crew
5.83 Crew Hours, say 8 hours
$ 2,000.00 Cost per hour per crew, including traffic control
$ 2.55 per cubic foot removed
$ 68.98 per cubic yard removed from Catch Basins
$ 16,000.00 say $ 20,000.00 per year

Ponds and Sumps Clean 20% of sumps annually
$ 137.96 Cost per yard removed from Sumps
$ 68.98 Cost per yard removed from Ponds

PENN		$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34		$ -
WENTWORTH		$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58		$ -
PORTLAND		$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05		$ -
TH 77		$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57		$ -

West Pond Clean every 10 years
$ 68.98 per cubic yard removed from Ponds

ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
WEST POND (I-35W OUTLET POND)	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40

SEDIMENT LOCATION	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST
INTAKES/CATCH BASINS	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 60,000.00
PENN	$ -	$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34	$ -	$ -
WENTWORTH	$ -	$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58	$ -	$ -
PORTLAND	$ -	$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05	$ -	$ -
TH 77	$ -	$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57	$ -	$ -
ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
OUTLET POND	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40
ANNUAL TOTAL	$ 29,600.00	$ 49,403.59	$ 36,708.98	$ 36,708.98	$ 36,708.98	$ 29,600.00	$ 69,600.00
PRESENT VALUE	$ 580,000.00	$ 968,000.00	$ 719,000.00	$ 719,000.00	$ 719,000.00	$ 580,000.00	$ 1,364,000.00

5% Inflation Rate
80 Year Economic Lifespan

Appendix B

Alternative 2C – Use Existing Sewer with Adjacent Surface Ponding

Outfall Location

No new outfalls would be constructed for Alternative 2C. The existing outfall from Almaz Pond, and the Almaz Pond Bypass would direct discharge to the existing outfall structure.

Conveyance System and Rate Control

Under Alternative 2C, the existing drainage system is utilized from Portland Avenue all the way to Almaz Pond; pipes upstream of Portland are replaced by larger pipe for increased capacity and to allow for the reduction in cover caused by the revised roadway profile. Four new ponds are used to detain runoff volumes and limit discharge to the conveyance capacity of the downstream system. In doing so, and by eliminating surcharging and flooding, Alternative 2C will reduce the overall discharge rate to the Minnesota River and exceed rate control requirements of the LMRWD. (The existing system surcharges and floods during both the 50- and 100-year events; see Wenck, 2004, Appendix H.)

Sizing ponds and diversion structures for Alternative 2C was subject to constraints of high groundwater, a low road profile, and an undersized trunk sewer system. The ground next to the highway is relatively high so that the normal pond elevations are 20 to 30 feet below grade. The pond bottom elevations were set at or above minimum groundwater elevations determined from groundwater monitoring data collected as part of this study (Wenck 2004, Appendix H). Pond area and outlet structures were sized so that the trunk system upstream and downstream of the pond did not surcharge during the 50-year event. Preliminary XP-SWMM model results were used to estimate the necessary pond volume and elevation constraints were used to estimate the pond area. The ponds and outlets were tested with the assistance of the XP-SWMM model in an iterative process.

Ponds were not feasible at 24th and 12th Avenues because the groundwater was close to, or above the soffit of the trunk sewer pipe. Ponds were developed at Penn, Wentworth and Portland Avenues and at TH 77. The pond dimensions are summarized in Table B-1 and their designs are described below:

- **Penn Avenue Pond and Pump Station.** The Penn Avenue pump capacity is set as 3.5 cfs (1,600 gpm) to lift the entire 100-year runoff volume in 24-hours. The pump would deliver the flow to the trunk sewer at Colfax Avenue through a 4,000-ft, 15-inch force main. The pump would require a head of about 30 feet and a power of 11 kW. The pond is sized to work in conjunction with the pump to contain excess runoff to the Penn Avenue low point. (The final design might consider sizing the pond to contain the entire 6.9 ac-ft runoff from the 14.5-acre Penn Avenue drainage area without operation of the pump.)
- **Wentworth Avenue Pond.** The Wentworth pond works in series (on-line) with the trunk sewer, so that drainage from the entire upstream watershed (116 acres including Penn) flows through the pond. Wentworth was modeled as two equal-sized ponds, one on each side I-494. Inflows to the low point are introduced directly to the ponds to avoid surcharging the upstream trunk sewer. The ponds discharge through 24-inch diameter outlet pipes back to the trunk line, downstream of the highway low point.
- **Portland Avenue Pond.** The Portland Avenue pond accepts drainage from 45 acres tributary to the Portland Avenue low point. It works in parallel with the trunk line and discharges through a 24-inch outlet pipe, which enters the trunk sewer downstream of the low point. The Portland pond is relatively large in area due to the groundwater elevation constraint.
- **TH 77 Pond.** The TH 77 pond accepts drainage from 94 acres tributary to the TH 77 low point. It works in parallel with the trunk line and discharges through a 24-inch outlet pipe, which enters the trunk sewer downstream of the low point.

Table B-1 Option 2C Existing Sewer with Adjacent Surface Ponding

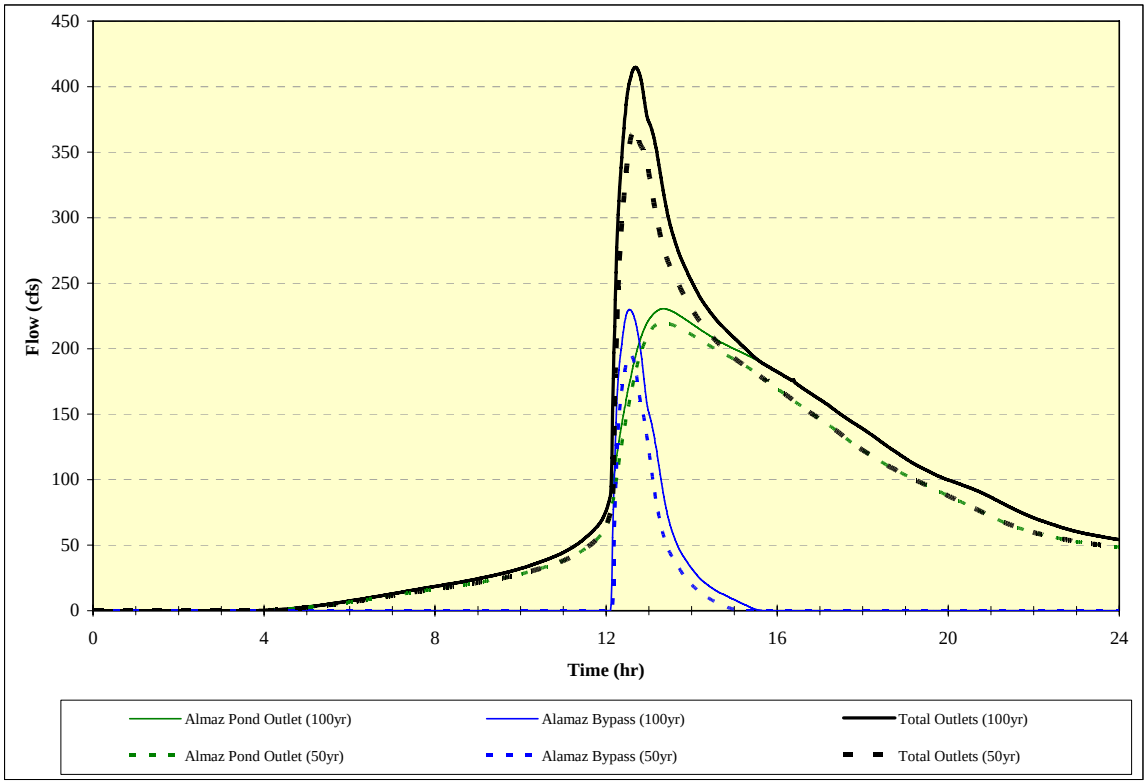
Pond Name/Location	Penn Pond (Pumped)	Wentworth Pond	Portland Pond	TH 77 Pond
Pond Dynamics	In-Series with Trunk Line	In-Series with Trunk Line	Flow not from Trunk Line	Flow not from Trunk Line
Contributing Watersheds	Penn	Colfax, Garfield, Pleasant, and Nicollet	Portland	TH 77
Peak 50-year Discharge Upstream of Pond				
Trunk Sewer (cfs)	85	330	104	178
Intervening Drainage to Low Point (cfs)	0	181	228	206
Groundwater elevation (ft)	811.2	811.1	809.8	804.2
Pond Size (Total Area and Volumes)				
Pond Area (ac)	0.8	3.3	4.8	1.7
Pond Bottom Elevation (ft)	811.2	811.1	809.8	804.2
Peak Elevation (ft)	814.8	816.8	811.4	810.6
Bounce (ft)	3.6	5.7	1.6	6.4
Storage (ac-ft)	2.9	20.4	7.7	15.0
Total 50-year Storage for all Ponds (ac-ft)				46.0
Pond Outlet Pipes				
Diameter (in)	15"	24" (2)	24"	24"
Length (ft)	4,000	200	200	200
50-year peak discharge (cfs)	3.5(pumped)	104	27	43
Mainline Pipe Downstream of Pond Outlets				
50-year peak discharge including pond discharge (cfs)	N/A	104	197	289
Pipe capacity (cfs)	N/A	169	177	263

Alternative 2C meets the rate control requirements for the total system discharge rate (note that the total system peak flow rate is smaller than the sums of the individual locations due to the different times to peak; see Figure B-1):

Table B-2 Alternative 2C Peak Flow Rates (cfs)

Location	Rainfall Frequency	
	50-yr, 24-hr	**100-yr, 24-hr**
Total System	365	414
Almaz Outlet	220	230
Almaz Bypass	193	226

The Alternative 2C discharge to the Minnesota River is shown in the combined hydrograph in Figure B-1 below.



Individual Outfall, and Combined Hydrographs for Alternative 2C Discharge to the Minnesota River
Figure B-1

Water Quality

In Alternative 2C, the entire 2.5-inch storm runoff volume, 52 acre-feet, is directed to Almaz Pond. With a dead volume of 19 acre-feet, Almaz Pond is substantially undersized for water quality treatment. Therefore, each of the upstream stormwater detention ponds also includes a dead volume equal to the runoff from the 2.5-inch storm, totaling 37 acre-feet. Including the 19 ac-ft of Almaz, the total pond volume of Alternative 2C is 56 ac-ft.

The PondNet (Walker, 1987) water quality model was used to evaluate the overall effectiveness of the Alternative 2C ponds (Wenck 2007c, Appendix H). With each pond sized according to the 2.5-inch storm runoff, the model predicts annual phosphorus removal of 57 percent; if pond volume is reduced by 20 percent to account for sedimentation, the model still predicts removal of 54 percent. This is due to the fact that discharge from the upstream ponds is treated a second time in Almaz Pond, even though the effectiveness of Almaz Pond is reduced by the short residence time. Since the combined volume is oversized, the Penn Avenue pond can be constructed as a dry pond (no dead volume) and the overall system performance would drop just one percent. See Appendix H for details of the analysis.

Sediment

Sediment from the I-494 drainage system would collect in the ponds, roughly in proportion to the flow volume entering each one. The total suspended sediment load for the I-494 drainage system is estimated as 400,000 lb/yr; this represents a total volume of roughly 5,000 ft^3/yr, or 2.3 ac-ft over a twenty-year period. (This is based on a typical total suspended solids concentration of 300 mg/L, and equivalent to about 900 lb/acre.) No special consideration of sediment was included since removal from the surface ponds is routine.

Maintenance

As per the sedimentation discussion in Section 3, even though Mn/DOT does not use sand for snow and ice control along this section of highway, the accumulation of sediment still occurs. This material finds its way to the site on the tires of vehicles entering from sandy areas, as wind blown debris from off site, or from open topped loads of sand and aggregate that traverse the highway.

Regardless of the drainage Alternative selected, the total amount of sediment generated over the 438 acre site will remain constant. This is estimated at 4,468 cubic feet of material each year. Although a consistent street sweeping program can capture half of this material, our estimates assume that all suspended solids are conveyed to the storm sewer system.

For Alternatives 2C, which reuses the existing storm sewer system, catch basins at each storm sewer intake location will capture a large portion of the suspended solids. Further downstream, the control structures associated with each of the four ponds will be designed such that the majority of low flows will bypass the ponds altogether, carrying suspended solids to Almaz Pond. Under larger events, each detention basin in the system will be expected to capture a portion of the remaining annual sediment load (see Sediment section above).

Our assumption is that Almaz Pond, and the four ponds at Penn, Wentworth, Portland, and TH 77, will be cleaned of accumulated sediment every ten years. As with other existing detention basins, cleaning will occur during the winter, when water levels are low and access by tracked excavators and dump trucks can be made over frozen ground.

We have further assumed that 20% of the individual catch basins will be cleaned each year. This will be accomplished through the use of purpose built vacuum trucks, accompanied by necessary and required support vehicles and traffic control.

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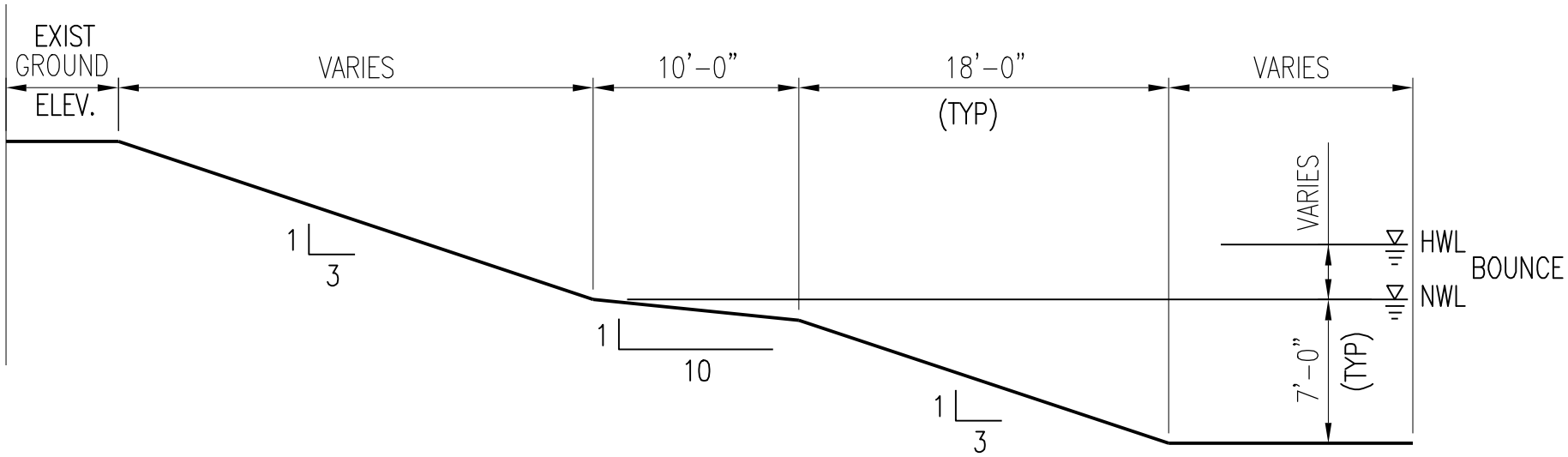

LOCATION	GROUND ELEVATION	GROUNDWATER TABLE	EXISTING SYSTEM INVERT	BOUNCE (ft)	
PENN AVE.	830	811.2	811.8	3.6	
WENTWORTH AVE.	840	811.1	811.5	6.2	
PORTLAND AVE.	830	809.8	805.1	1.3	
TH 77	825	804.2	799.0	1.7	

FIGURE B–2
TRADITIONAL CUT POND
I–494 STORMWATER ALTERNATIVES STUDY

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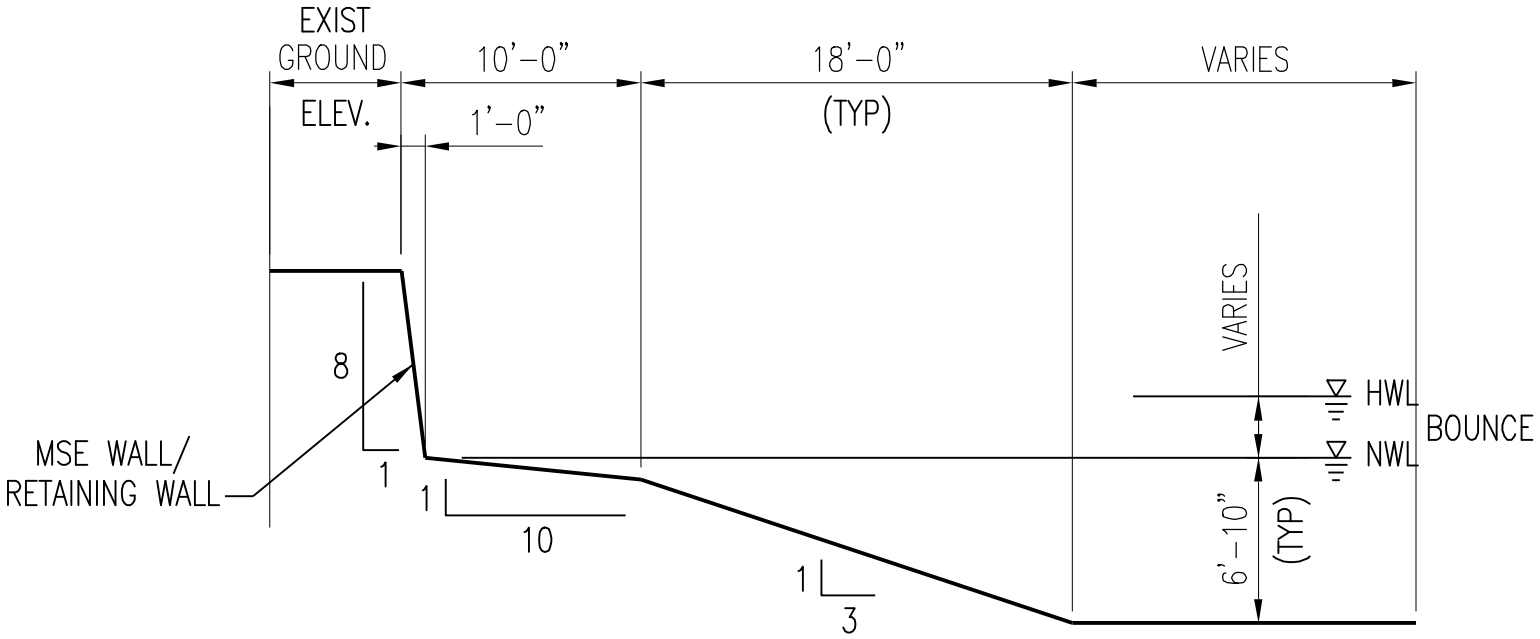

LOCATION	GROUND ELEVATION	GROUNDWATER TABLE	EXISTING SYSTEM INVERT	BOUNCE (ft)
PENN AVE.	830	811.2	811.8	3.6
WENTWORTH AVE.	840	811.1	811.5	6.2
PORTLAND AVE.	830	809.8	805.1	1.3
TH 77	825	804.2	799.0	1.7

FIGURE B–3
MODIFIED POND WITH MSE WALL/RETAINING WALL
I–494 STORMWATER ALTERNATIVES STUDY

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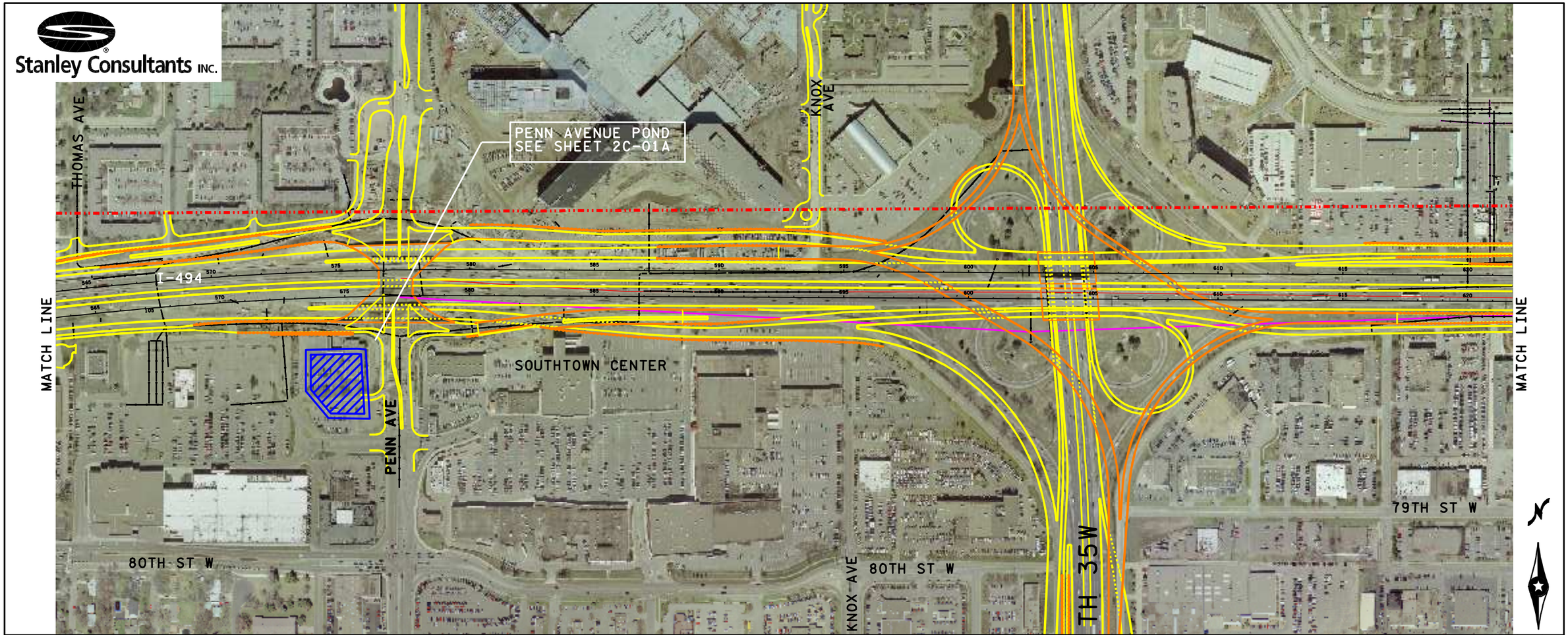

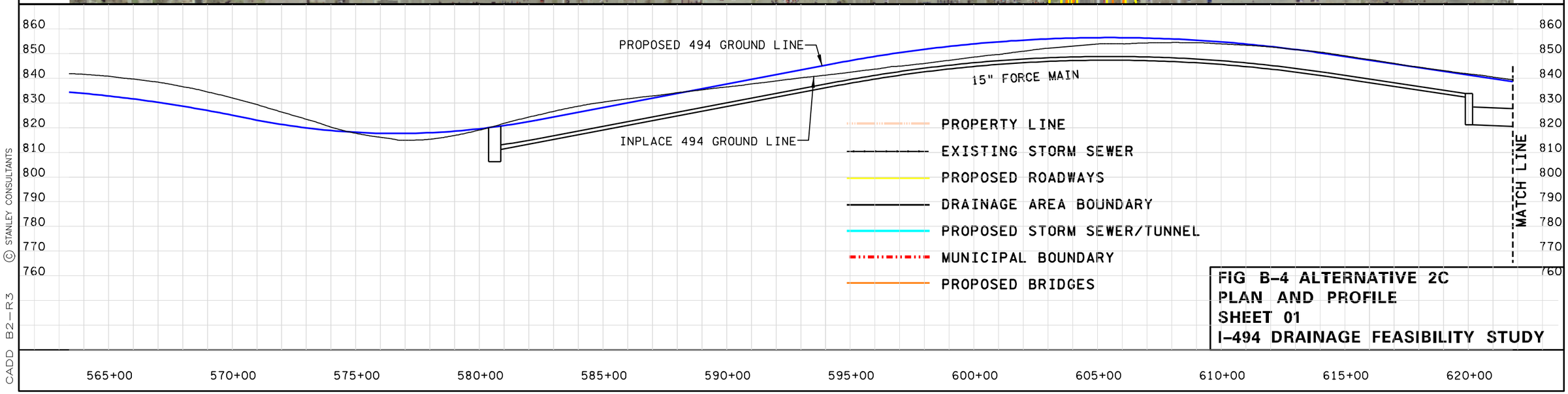

FIG B-4 ALTERNATIVE 2C
PLAN AND PROFILE
SHEET 01
I-494 DRAINAGE FEASIBILITY STUDY

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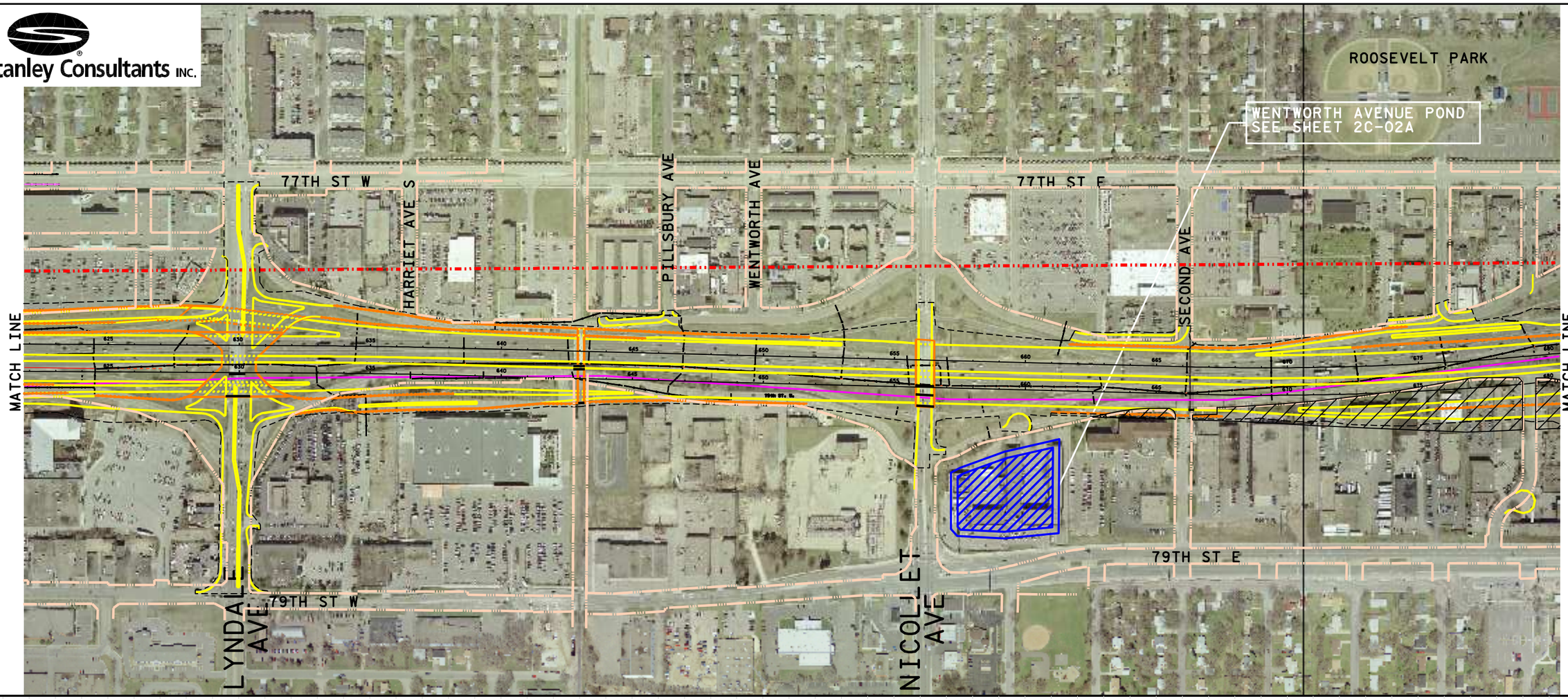

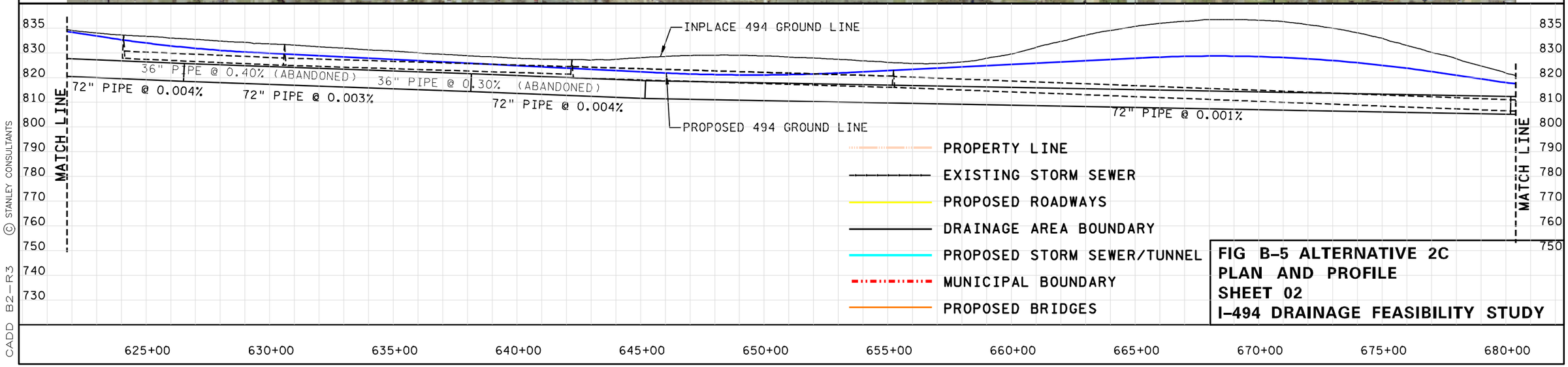

FIG B-5 ALTERNATIVE 2C
PLAN AND PROFILE
SHEET 02
I-494 DRAINAGE FEASIBILITY STUDY

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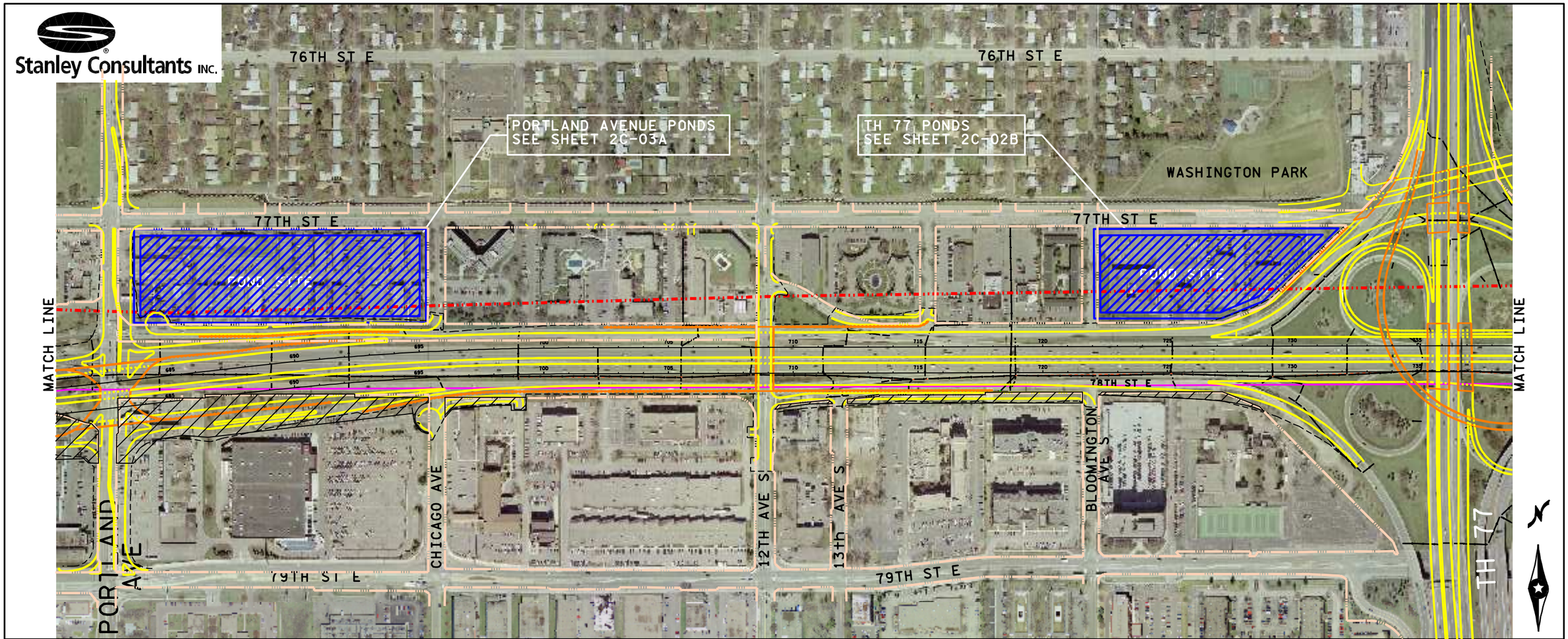

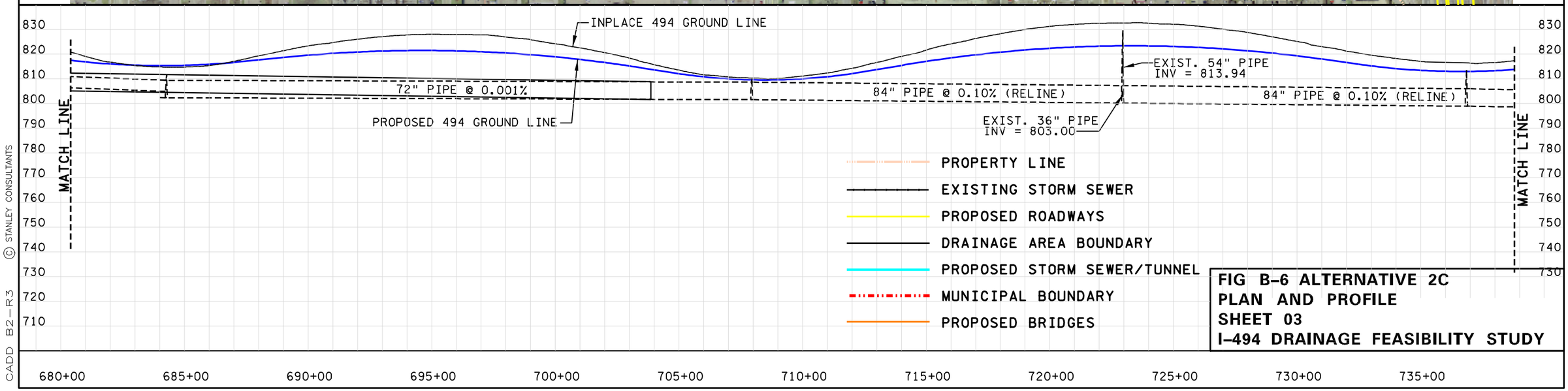

FIG B-6 ALTERNATIVE 2C
PLAN AND PROFILE
SHEET 03
I-494 DRAINAGE FEASIBILITY STUDY

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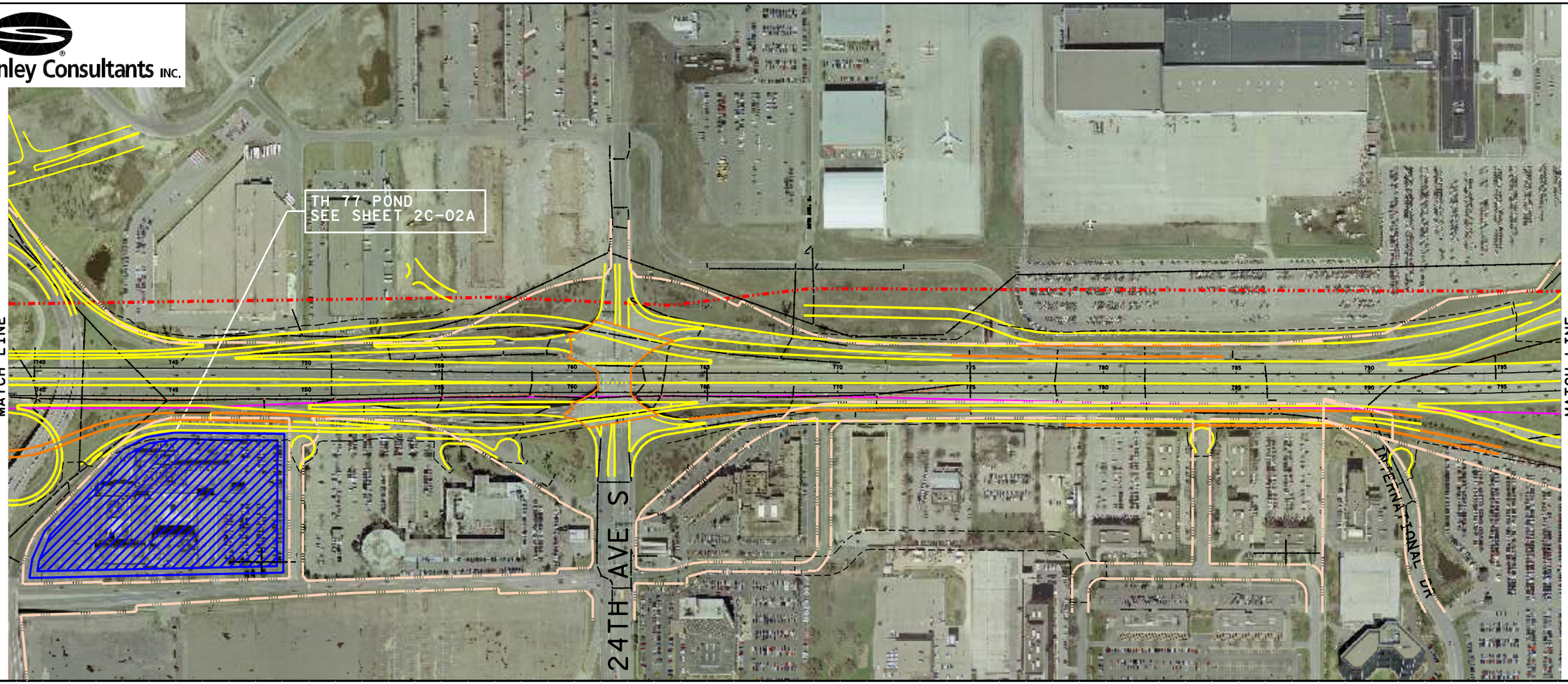

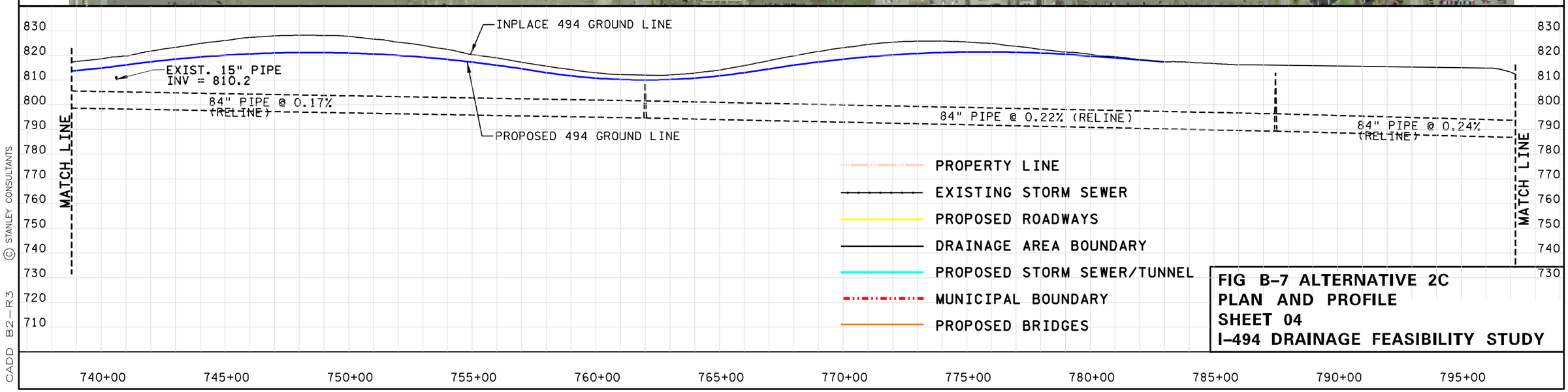

FIG B-7 ALTERNATIVE 2C
PLAN AND PROFILE
SHEET 04
I-494 DRAINAGE FEASIBILITY STUDY

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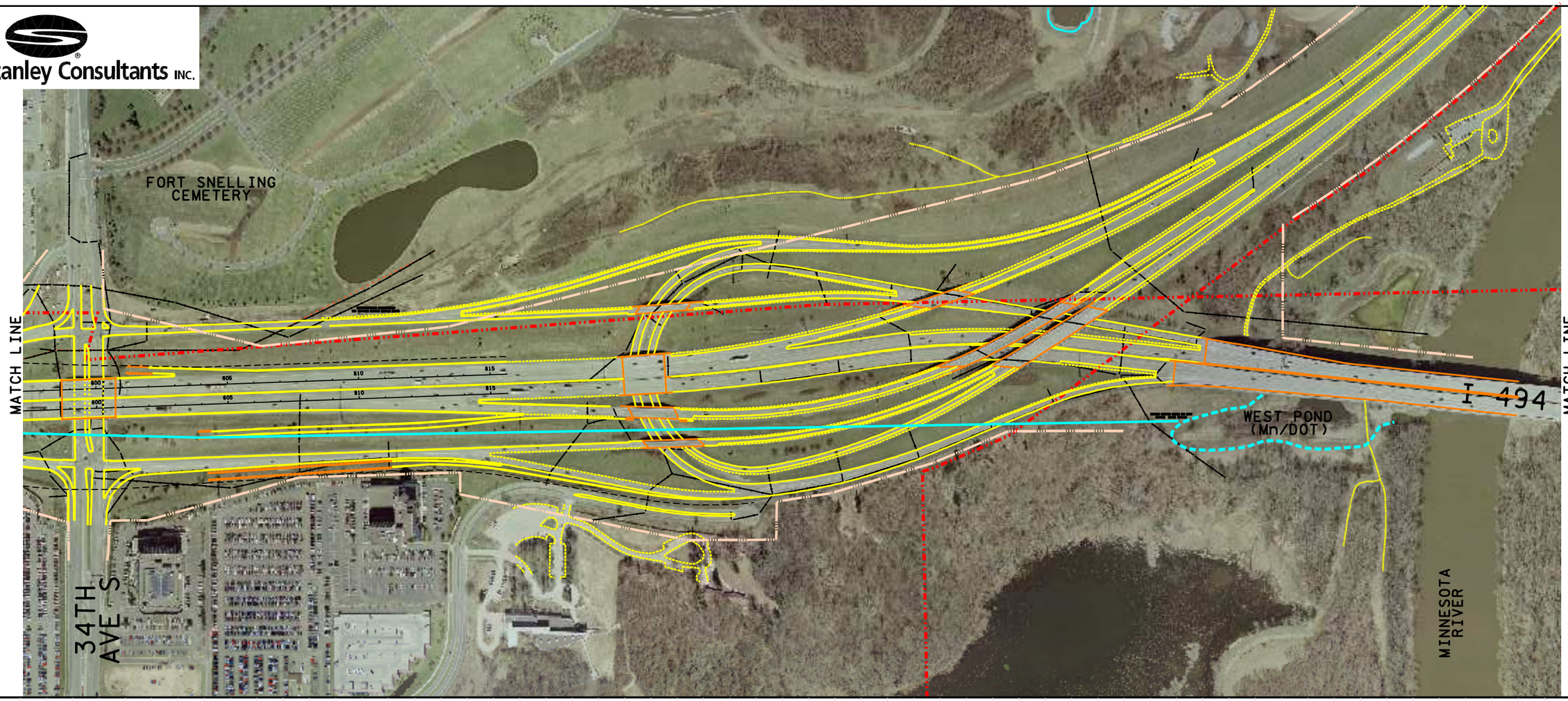

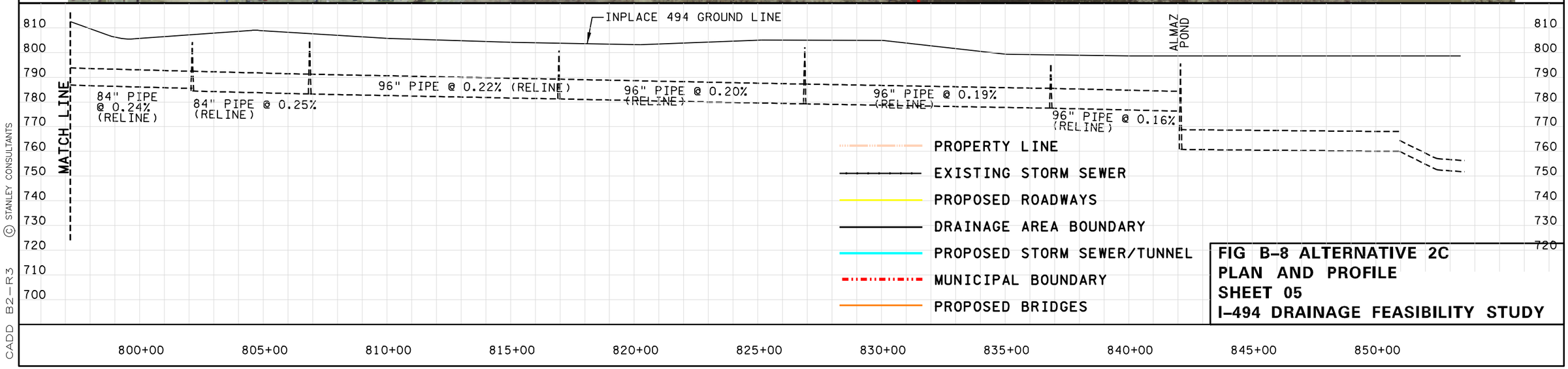

FIG B-8 ALTERNATIVE 2C
PLAN AND PROFILE
SHEET 05
I-494 DRAINAGE FEASIBILITY STUDY

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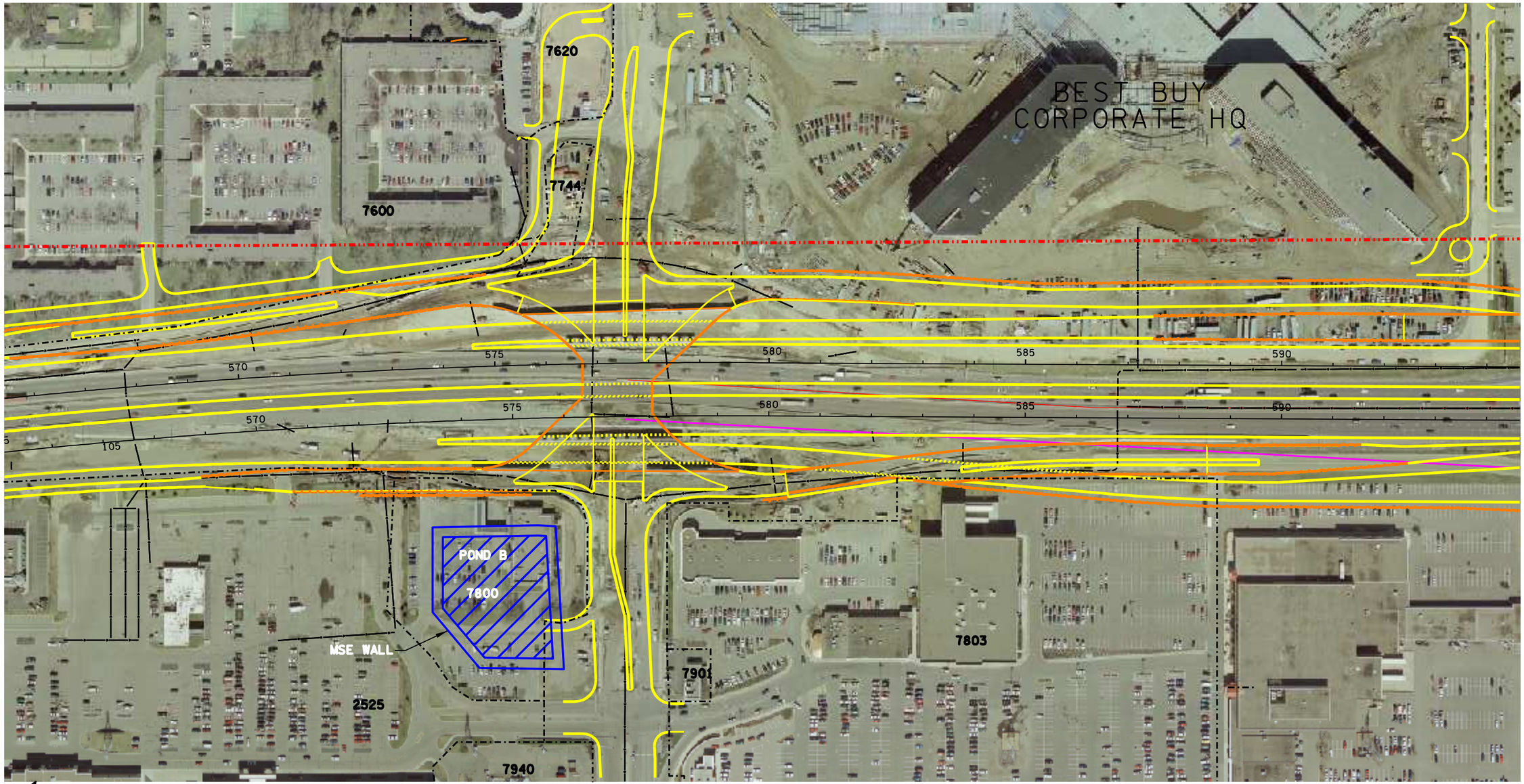

POND B
LIVE STORAGE: 3.4 AC-FT
DEAD STORAGE: 3.6 AC-FT

PROPERTY INFO
OWNER: TWIN CITY FED SAVE & L ASSOC
ADDRESS: 7800 PENN AVE S BLMTG
SIZE: 3.06 ACRE +/-

SCALE: 1" = 200'

FIG B-9 ALTERNATIVE 2C-01A
ENLARGED PLAN AND PROFILE, SECTIONS
I-494 DRAINAGE FEASIBILITY STUDY

CADD B2-R3 © STANLEY CONSULTANTS

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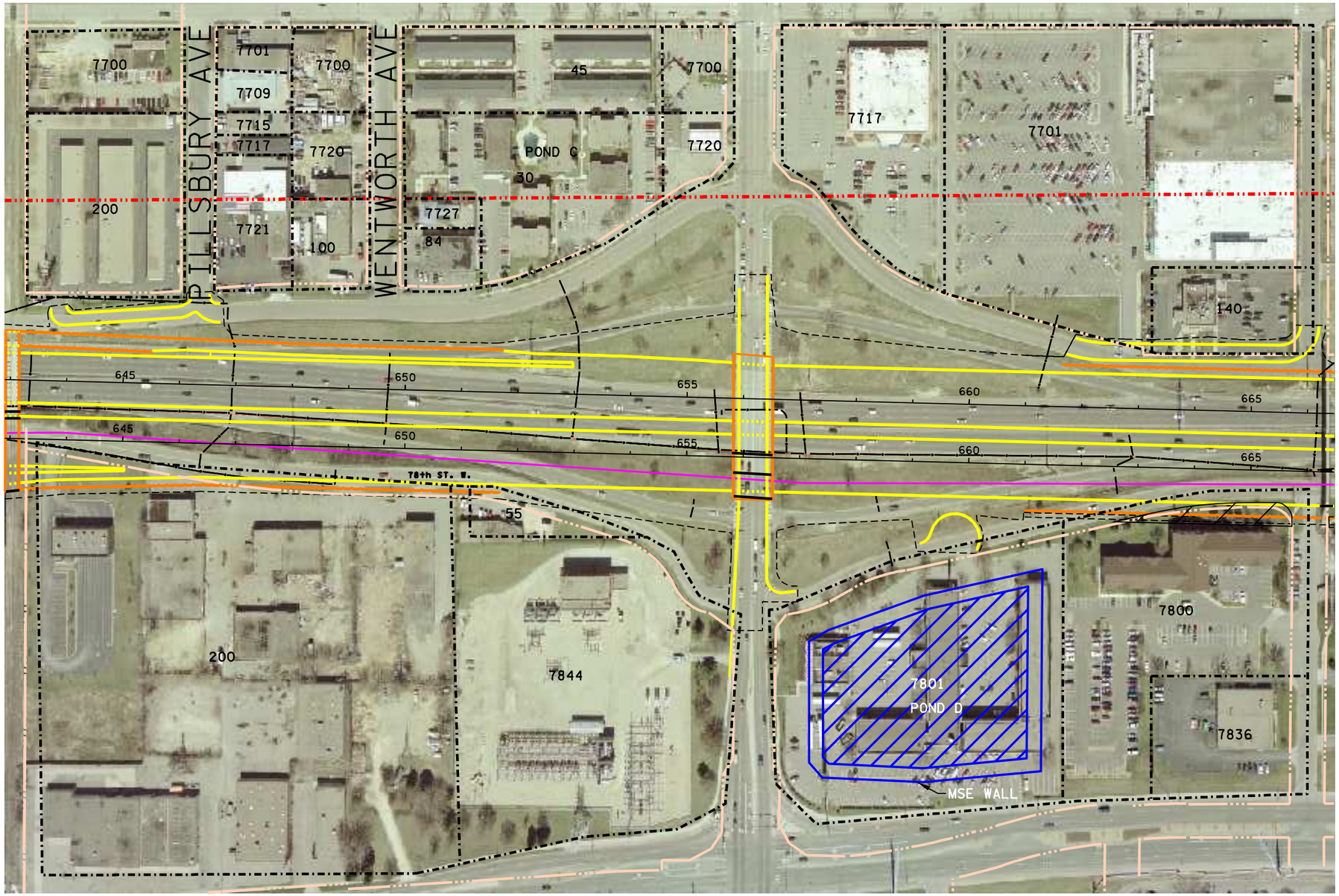

POND D
LIVE STORAGE: 16.3 AC–FT
DEAD STORAGE: 11.3 AC–FT

PROPERTY INFO
OWNER: A G BOGEN COMPANY ET AL
ADDRESS: 7801 NICOLET AVE S BLMTG
SIZE: 5.28 ACRE +/–

SCALE: 1" = 200'

FIG B–10 ALTERNATIVE 2C–02A
ENLARGED PLAN AND PROFILE, SECTIONS
I–494 DRAINAGE FEASIBILITY STUDY

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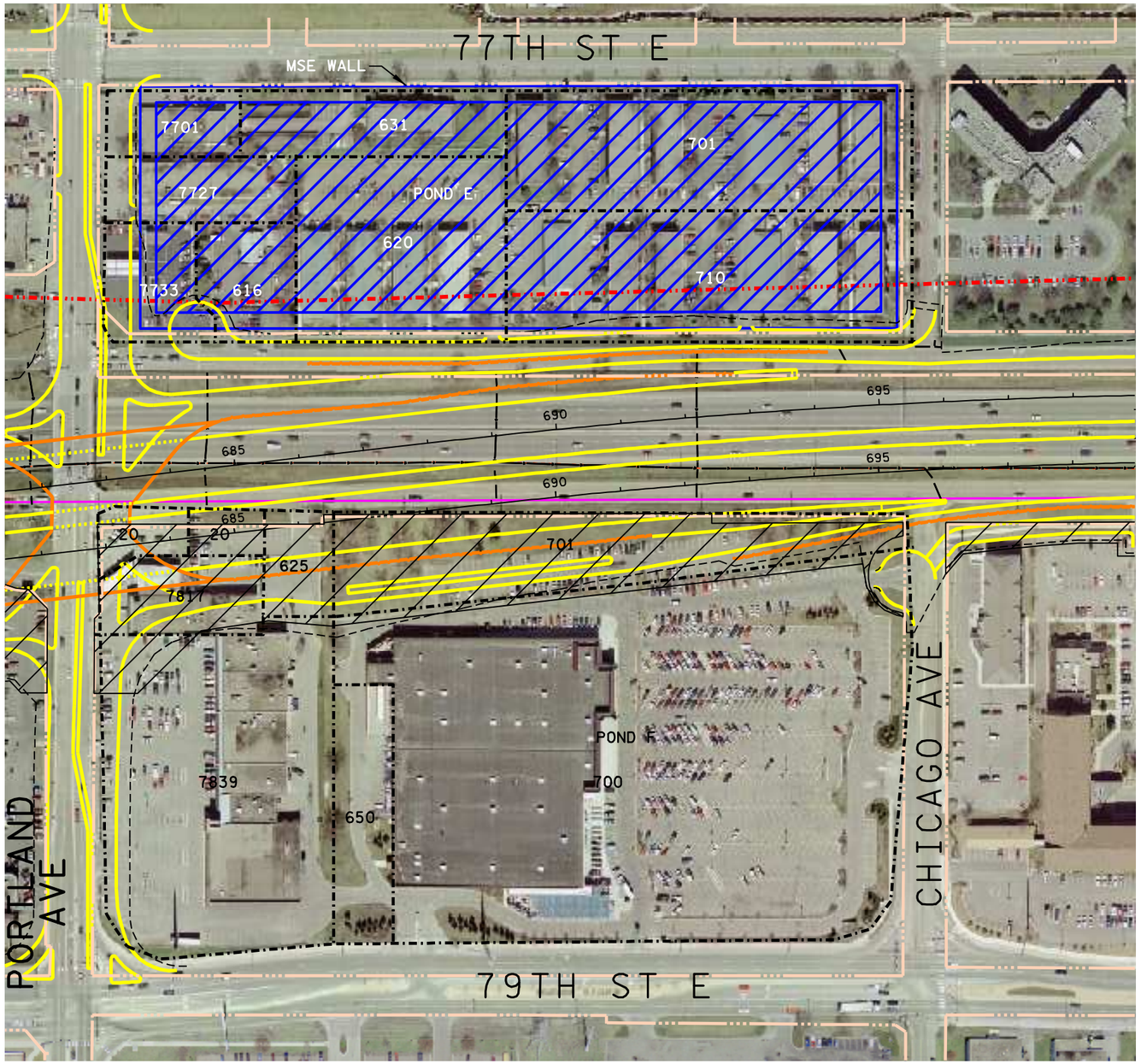

POND E
LIVE STORAGE: 11.0 AC-FT
DEAD STORAGE: 46.7 AC-FT

PROPERTY INFO
OWNER: ASIAN DRCT ORIENTAL MKT INC
ADDRESS: 7701 PORTLAND AVE RCHF
SIZE: 0.50 ACRE

PROPERTY INFO
OWNER: CAROLE L BOYUM
ADDRESS: 631 77TH ST E RCHF
SIZE: 0.94 ACRE

PROPERTY INFO
OWNER: HOMES RE 1 LLC
ADDRESS: 7727 PORTLAND AVE S RCHF
SIZE: 0.66 ACRE

PROPERTY INFO
OWNER: SINCLAIR MARKETING
ADDRESS: 7733 PORTLAND AVE S RCHF
SIZE: 0.63 ACRE +/-

PROPERTY INFO
OWNER: LOIS BERG ET AL
ADDRESS: 616 78TH ST E RCHF
SIZE: 0.60 ACRE +/-

PROPERTY INFO
OWNER: RICHFIELD APTS CENTER LLC
ADDRESS: 620 78TH ST E RCHF
SIZE: 2.08 ACRE

PROPERTY INFO
OWNER: RICHFIELD APTS CENTER LLC
ADDRESS: 701 77TH ST E RCHF
SIZE: 2.85 ACRE

PROPERTY INFO
OWNER: RICHFIELD APTS CENTER LLC
ADDRESS: 710 78TH ST E RCHF
SIZE: 2.68 ACRE

SCALE: 1" = 200'

FIG B-11 ALTERNATIVE 2C-03A
ENLARGED PLAN AND PROFILE, SECTIONS
I-494 DRAINAGE FEASIBILITY STUDY

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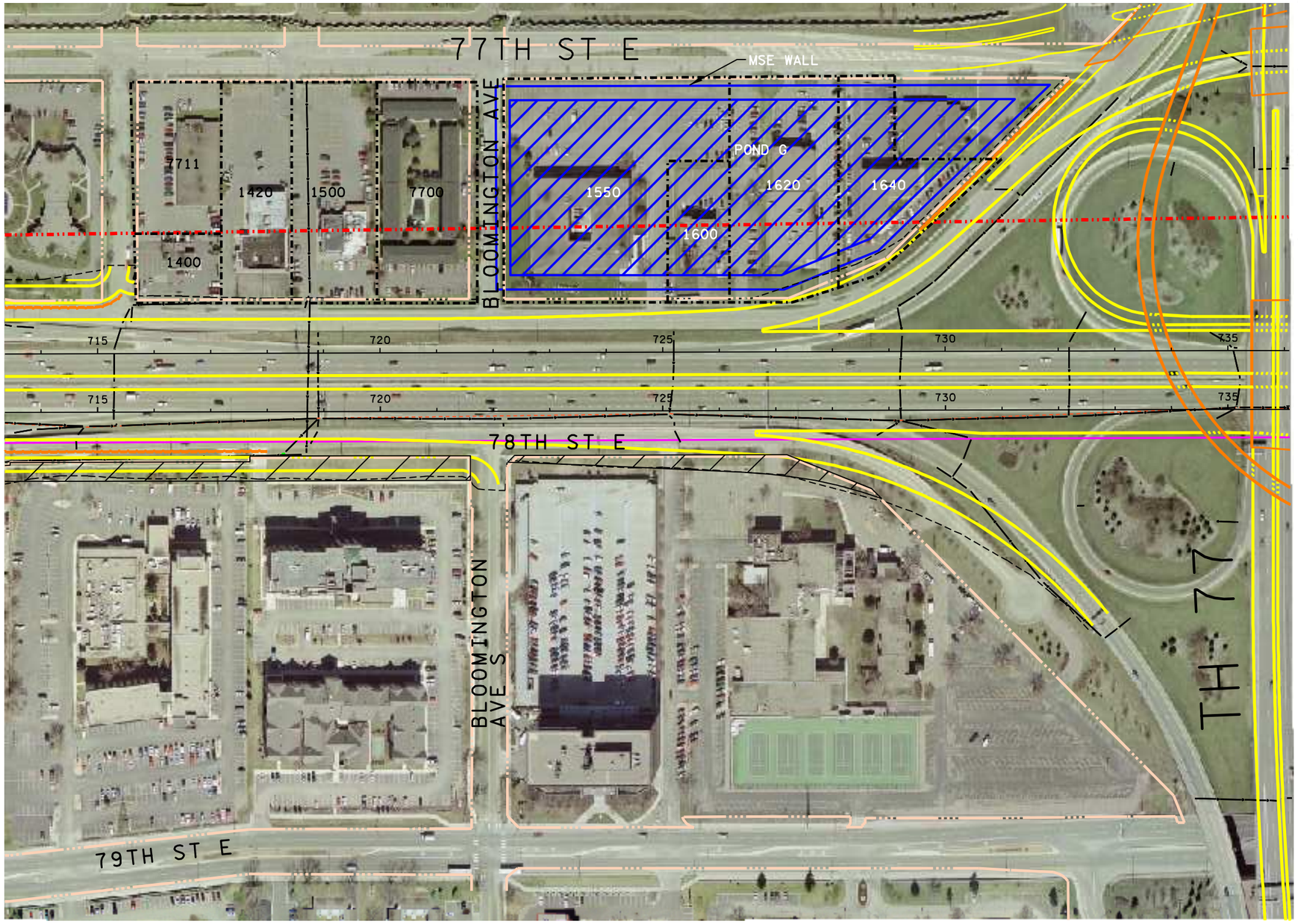

POND G
LIVE STORAGE: 4.5 AC-FT
DEAD STORAGE: 14.4 AC-FT

PROPERTY INFO
OWNER: OLIN-MATHWIG LLC
ADDRESS: 1550 78TH ST E RCHF
SIZE: 2.99 ACRE +/-

PROPERTY INFO
OWNER: JERRY E MATHWIG
ADDRESS: 1620 78TH ST E RCHF
SIZE: 1.74 ACRE +/-

PROPERTY INFO
OWNER: JERRY E MATHWIG
ADDRESS: 1640 78TH ST E RCHF
SIZE: 2.01 ACRE +/-

NOTE: 1600 78TH ST E - DIVISON IN PROGRESS

N

SCALE: 1" = 200'

FIG B-12 ALTERNATIVE 2C-03B
ENLARGED PLAN AND PROFILE, SECTIONS
I-494 DRAINAGE FEASIBILITY STUDY

CADD B2-R3 © STANLEY CONSULTANTS

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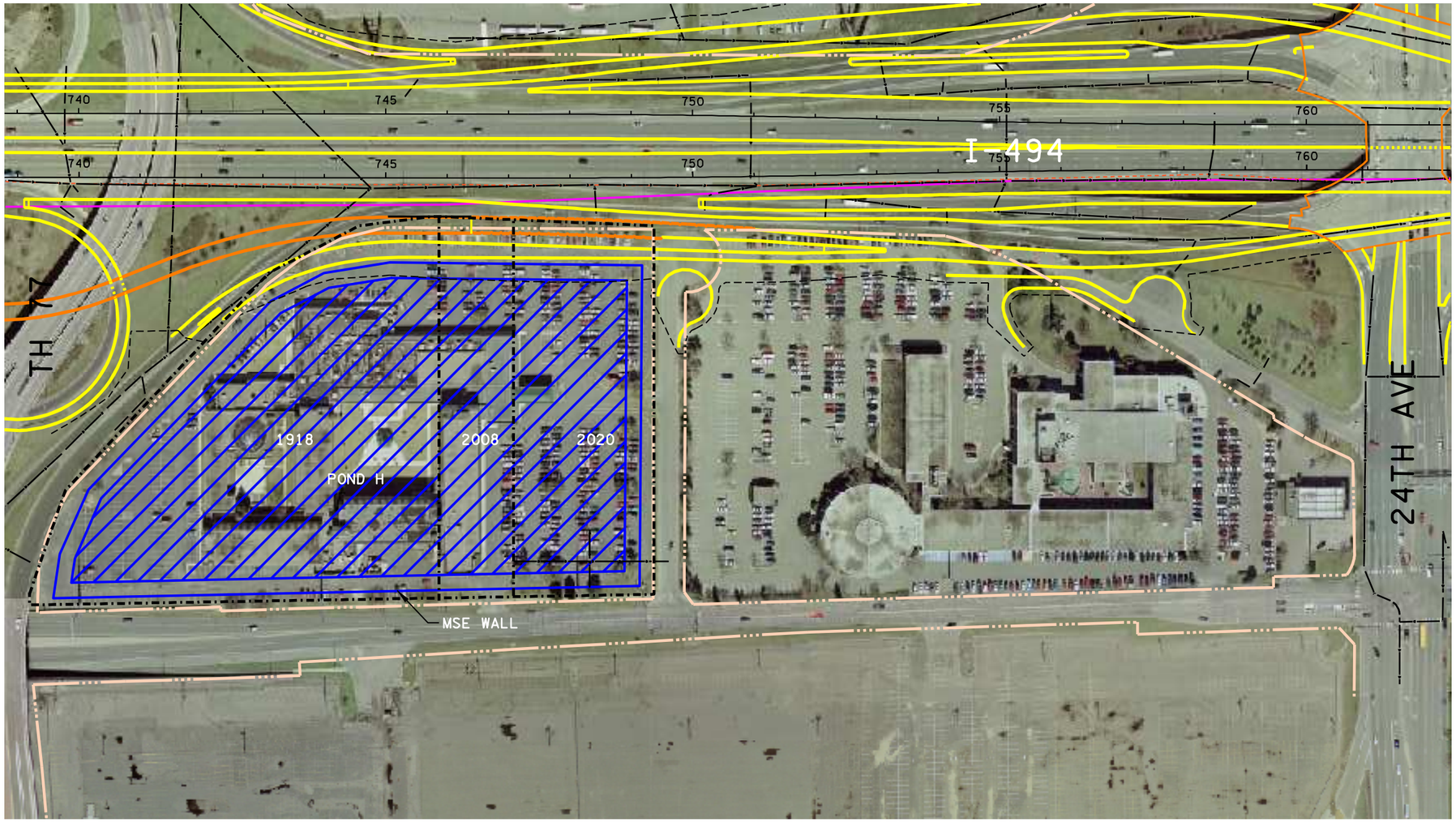


POND H
LIVE STORAGE: 6.7 AC-FT
DEAD STORAGE: 21.5 AC-FT

PROPERTY INFO
OWNER: COLUMBIR PROPERTIES MPLS LTC
ADDRESS: 1918 AMERICAN BLVD E BLMTG
SIZE: 6.68 ACRE +/-

PROPERTY INFO
OWNER: COLUMBIR PROPERTIES MPLS LTC
ADDRESS: 2008 AMERICAN BLVD E BLMTG
SIZE: 1.47 ACRE

PROPERTY INFO
OWNER: COLUMBIR PROPERTIES MPLS LTC
ADDRESS: 2020 AMERICAN BLVD E BLMTG
SIZE: 3.18 ACRE +/-

N

SCALE: 1" = 200'

FIG B-13 ALTERNATIVE 2C-04A
ENLARGED PLAN AND PROFILE, SECTIONS
I-494 DRAINAGE FEASIBILITY STUDY

CADD B2-R3 © STANLEY CONSULTANTS

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 2C	**Existing Sewer with Adjacent Ponding**	Ponds easier to clean			x	x	x
		Meets water quality standards			x		x
	Rehabilitate and reuse the in place storm sewer.	Decision needed soon[10]	x				
	Provide detention and water quality storage in new	Provide all needed sediment and phosphorus removal					x
	ponds constructed adjacent to the highway.	Possibly pump water to Wood Lake		x			
		Use a tunnel from Penn to Lyndale and then ponds east of Lyndale		x			
	Ponds provided at four locations for detention and	Water can drain into Almaz (state pond)					x
	water quality storage - Penn Ave., Wentworth Ave.,	Additional space may be available for underground storage[9]	x				
	Portland Ave., and TH77.	Richfield has many older sites in need of redevelopment	x				
	Penn Ave stormwater will be pumped	More land needed[19]			x		
	Pipes upstream of Portland are replaced	Ponds 20 feet below ground					x
	Doesn't use West Pond	Restricted by pipe capacity[20]					x
	Uses Almaz Pond for water quality	Resistance from Cities[8]	x	x			
	Outfall is at Almaz	Lower MN Watershed permit required				x	
		Existing system does not cover entire corridor					x
		Pond locations subject to change	x	x			
		Maintenance component to upstream sediment basins	x				x
		Economical loss[22]	x	x			
		Expensive land[21]	x	x			x
		Existing pipe deterioration					x
		Existing pipe relining					x
		Potential for additional storage at West Pond					x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION	STAKEHOLDER CONCERNS	
	This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington Richfield Nine Mile Lower MN Mn/DOT

Notes:

1. Water could still be taken down to the river and treated at those ponds.
2. Met water quality standard.
3. Based on the same information as Mn/DOT.
4. The pumps would go into the new system and would not need to be programmed on a hydrograph schedule.
5. These possibilities include: remote control vehicles, future technology, better street sweeping to prevent build up of sediment in the tunnel, and stormcepters.
6. This is already an expensive project. Even if the tunnel ends up costing more, it may be worth the extra expense to avoid having to acquire more land.
7. The City of Bloomington has a much shorter timeframe than Mn/DOT, and needs to provide funding
8. Massive political problems (Richfield's land use plan is already done).
9. This space is located in Bloomington by 24th and I-494 by the airport.
10. Because of all the current construction in these areas, the Cities need to know what land the ponds will be built on so they can to help protect this land.
11. It is needed for longer term detention downstream.
12. This assumes peak flow is allowed without detention.
13. Sediment may get into the tunnel and than it will need to be removed.
14. The tunnel is more difficult to clean out then the surface ponds.
15. Maintenance costs and techniques for buried storage of this magnitude are difficult to calculate because of the lack of existing comparable systems.
16. Not used.
17. Rate control standards are not met.
18. The ponds in Bloomington that are located below the bluff are currently not meeting capacity and need maintenance.
19. This includes land beyond the ROW.
20. This leads to flooding at the low points along the corridor.
21. Richfield would double the property cost listed on the Hennepin County Assessor's site.
22. The combination of cost and disruption to the Cities is very high.

CONCEPTUAL COST ESTIMATE BASED ON FIGURE 03 USE OF RETAINING WALLS
I-494 STORMWATER ALTERNATIVES STUDY

Apr-07

				TOTAL ESTIMATED QUANTITIES - INITIAL CONSTRUCTION	TOTAL ESTIMATED COST - INITIAL CONSTRUCTION	TOTAL ESTIMATED QUANTITIES - RECONSTRUCTION	TOTAL ESTIMATED COST - RECONSTRUCTION
				2C	2C	2C	2C
PRE-CONSTRUCTION - ENGINEERING AND DESIGN		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
ENGINEERING AND DESIGN			VARIES	12.00%	$3,609,159.12	12.00%	$1,977,013.81
Assume a set percentage of the construction cost, less right-of-way and acquisition							
					$3,609,159.12		$1,977,013.81

PRE-CONSTRUCTION - RIGHT-OF-WAY		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
RIGHT OF WAY and EASEMENTS		LUMP SUM	VARIES	$139,700,495.05	$139,700,495.05	$0.00	$0.00
RELOCATION and REESTABLISHMENT		LUMP SUM	VARIES	$6,340,000.00	$9,340,000.00	$0.00	$0.00
PAVEMENT REMOVAL and DEMOLITION		LUMP SUM	VARIES	$4,711,000.00	$4,711,000.00	$0.00	$0.00
					$150,751,495.05		$0.00

CONSTRUCTION - PHYSICAL CONSTRUCTION		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
RCP STORM SEWER, 36" DIAMETER (surface drainage system excluded)	2503.511/00363	LF	$60.00	200	$12,000.00	0	$0.00
RCP STORM SEWER, 48" DIAMETER (surface drainage system excluded)	2503.511/00483	LF	$90.00	0	$0.00	0	$0.00
RCP STORM SEWER, 60" DIAMETER (surface drainage system excluded)	2503.511/00603	LF	$160.00	0	$0.00	0	$0.00
RCP STORM SEWER, 72" DIAMETER (surface drainage system excluded)	2503.511/00723	LF	$220.00	6018	$1,323,960.00	0	$0.00
TUNNEL, 120" DIAMETER		LF	$3,000.00	0	$0.00	0	$0.00
TUNNEL, 144" DIAMETER		LF	$3,500.00	0	$0.00	0	$0.00
TUNNEL SHAFT HOLES		EACH	$280,000.00	0	$0.00	0	$0.00
TUNNEL DRILL HOLE/ACCESS SHAFT		EACH	$115,000.00	0	$0.00	0	$0.00
PORTAL WORK SITE (with tunnel alternatives only)		LUMP SUM	$115,000.00	0	$0.00	0	$0.00
DEWATERING		500' UNITS	$20,000.00	7	$140,000.00	1.76	$36,063.66
MICROTUNNEL, 42" DIAMETER		LF	$1,000.00	0	$0.00	0	$0.00
MICROTUNNEL ACCESS SHAFTS (every 500')		EACH	$115,000.00	0	$0.00	0	$0.00
FORCE MAIN, 16" STEEL	2504.603/02015	LF	$60.00	4000	$240,000.00	4000	$281,007.94
CATCH BASIN (ADDITIONAL DEPTH OF DRAINAGE STRUCTURE)	2506.501/03620	LF	$360.00	700	$266,000.00	0	$0.00
RESURFACE TEMPORARY ACCESS LOCATIONS, 8"	2360.501.23200	SF	$2.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 27" DIAMETER		LF	$20.00	801	$160,225.00	801	$196,000.85
REHABILITATE STORM SEWER, 36" DIAMETER		LF	$30.00	0	$0.00	700	$54,376.88
REHABILITATE STORM SEWER, 48" DIAMETER		LF	$40.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 60" DIAMETER		LF	$50.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 72" DIAMETER		LF	$80.00	0	$0.00	6018	$2,290,670.08
REHABILITATE STORM SEWER, 84" DIAMETER		LF	$70.00	11921	$5,226,450.00	11921	$5,687,199.66
REHABILITATE STORM SEWER, 96" DIAMETER		LF	$80.00	2465	$1,385,750.00	2465	$1,486,385.87
POND LOCATION NUMBER 1, PENN AVENUE							
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	55000	$440,000.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$9,000.00	1.52	$9,120.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	1100	$13,200.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)		LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03631	CUBIC YARD	$260.00	310	$77,500.00	80	$21,760.98
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
POND LOCATION NUMBER 2, WENTWORTH AVENUE							
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	124000	$992,000.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$9,000.00	0.4	$2,400.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	1300	$15,600.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)		LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03631	CUBIC YARD	$260.00	740	$185,000.00	190	$51,667.82
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	36900	$1,291,500.00	18450	$702,274.50
POND LOCATION NUMBER 3, PORTLAND AVENUE							
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	354000	$2,832,000.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$6,000.00	0.72	$4,320.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	2600	$31,200.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE LINER (To seal against groundwater infiltration)		SQUARE FOOT	$3.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)		LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03631	CUBIC YARD	$260.00	1180	$290,000.00	290	$78,846.15
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	51500	$1,802,500.00	25750	$990,139.21
POND LOCATION NUMBER 4, TH77							
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	564000	$4,512,000.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$6,000.00	1.28	$7,680.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	4600	$55,200.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE LINER (To seal against groundwater infiltration)		SQUARE FOOT	$3.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)		LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03631	CUBIC YARD	$260.00	1500	$375,000.00	360	$103,315.64
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	93400	$3,269,000.00	46700	$1,777,572.96
WEST POND EXPANSION (Or new pond for Alternative 4A)							
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	0	$0.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$6,000.00	0	$0.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03631	CUBIC YARD	$260.00	0	$0.00	0	$0.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
PUMP STATION, 3.5 CFS		LUMP SUM	$100,000.00	1	$100,000.00	0	$0.00
SUBTOTAL					$25,063,605.00		$13,729,282.59
CONTINGENCY				20.00%	$5,012,721.00	20.00%	$2,745,852.52
					$30,076,326.00		$16,475,115.11

CONSTRUCTION - CONSTRUCTION MANAGEMENT		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
CONSTRUCTION MANAGEMENT			VARIES	5.00%	$1,503,816.30	5.00%	$823,755.76
Assume a set percentage of the construction cost, less right-of-way and acquisition							
					$1,503,816.30		$823,755.76

POST-CONSTRUCTION - MAINTENANCE		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
MAINTENANCE			LUMP SUM	1	$968,000.00	0	$0.00
Present value of an annual sum							
					$968,000.00		$0.00

TOTAL PROJECT COST, INITIAL CONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES, YEAR 40	TOTAL ESTIMATED COST, PRESENT VALUE OF YEAR 40 CONSTRUCTION
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$3,609,159.12		$1,977,013.81
PRE-CONSTRUCTION - RIGHT-OF-WAY				$150,751,495.05		$0.00
CONSTRUCTION - PHYSICAL CONSTRUCTION				$30,076,326.00		$16,475,115.11
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$1,503,816.30		$823,755.76
POST-CONSTRUCTION - MAINTENANCE				$968,000.00		$0.00
				$186,908,796.47		**$19,275,884.68**

TOTAL PROJECT COST, YEAR 40 RECONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST, PRESENT VALUE OF YEAR 40 CONSTRUCTION
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$1,977,013.81
PRE-CONSTRUCTION - RIGHT-OF-WAY				$0.00
CONSTRUCTION - PHYSICAL CONSTRUCTION				$16,475,115.11
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$823,755.76
POST-CONSTRUCTION - MAINTENANCE				$0.00
				$19,275,884.68

TOTAL PROJECT COST, 80-YEAR LIFE CYCLE, 2007 DOLLARS	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	0
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$5,566,172.93
PRE-CONSTRUCTION - RIGHT-OF-WAY				$150,751,495.05
CONSTRUCTION - PHYSICAL CONSTRUCTION				$46,551,441.11
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$2,327,572.06
POST-CONSTRUCTION - MAINTENANCE				$988,000.00
				$206,184,681.15

MAINTENANCE COSTS
I-494 STORMWATER ALTERNATIVES STUDY

ALTERNATIVE	1C	2C	2D	2E	2F	4A	5A
SEDIMENT ACCUMULATION	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)
PENN		3300	3300	3300	3300		
WENTWORTH		26500	2100	2100	2100		
PORTLAND		10000	1400	1400	1400		
TH 77		29100	3800	3800	3800		
ALMAZ POND	26100	31300	89600	89600	89600	74100	26100
WEST POND	74100	0	0	0	0	26100	74100
	100200	100200	100200	100200	100200	100200	100200
20-year volume [ac-ft]	2.30	2.30	2.30	2.30	2.30	2.30	2.30

SEDIMENT COLLECTION

Use upstream catch basins to collect sediment prior to entry into mainline storm sewer *

Number of intakes, EA	175	175	175	175	175	175	525
Additional height per intake, FT	4	4	4	4	4	4	4
Assumed height of additional intakes, FT	700	700	700	700	700	700	2100
At 6' diameter, provided storage per unit, CF	113	113	113	113	113	113	113
Total Intake Storage Provided, CF	19775	19775	19775	19775	19775	19775	59325
Total Intake Storage Provided, CY	732	732	732	732	732	732	2197
Catch basin volume [ac-ft]	0.45	0.45	0.45	0.45	0.45	0.45	1.36

* Assume equivalent distribution over each ponding area

Sediment to be removed from sumps **

PENN		2475	2475	2475	2475		
WENTWORTH		19875	1575	1575	1575		
PORTLAND		7500	1050	1050	1050		
TH 77		21825	2850	2850	2850		
ALMAZ POND	19575	23475	67200	67200	67200	55575	19575
WEST POND	55575					19575	55575
20-year volume to Ponds	1.73	1.73	1.73	1.73	1.73	1.73	1.73
20-year volume to Catch Basins	0.58	0.58	0.58	0.58	0.58	0.58	0.58
20-year volume total	2.30	2.30	2.30	2.30	2.30	2.30	2.30

** Assume 25% of sediment is captured in the catch basins

Maintenance Assumptions

Catch Basins

20% Intakes cleaned annually
6,262.50 Sediment Cleaned Annually from sumps
6 Intakes per hour per crew
5.83 Crew Hours, say 8 hours
$ 2,000.00 Cost per hour per crew, including traffic control
$ 2.55 per cubic foot removed
$ 68.98 per cubic yard removed from Catch Basins
$ 16,000.00 say $ 20,000.00 per year

Ponds and Sumps Clean 20% of sumps annually
$ 137.96 Cost per yard removed from Sumps
$ 68.98 Cost per yard removed from Ponds

PENN		$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34		$ -
WENTWORTH		$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58		$ -
PORTLAND		$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05		$ -
TH 77		$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57		$ -

West Pond Clean every 10 years
$ 68.98 per cubic yard removed from Ponds

ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
WEST POND (I-35W OUTLET POND)	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40

SEDIMENT LOCATION	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST
INTAKES/CATCH BASINS	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 60,000.00
PENN	$ -	$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34	$ -	$ -
WENTWORTH	$ -	$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58	$ -	$ -
PORTLAND	$ -	$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05	$ -	$ -
TH 77	$ -	$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57	$ -	$ -
ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
OUTLET POND	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40
ANNUAL TOTAL	$ 29,600.00	$ 49,403.59	$ 36,708.98	$ 36,708.98	$ 36,708.98	$ 29,600.00	$ 69,600.00
PRESENT VALUE	$ 580,000.00	$ 968,000.00	$ 719,000.00	$ 719,000.00	$ 719,000.00	$ 580,000.00	$ 1,364,000.00

5% Inflation Rate
80 Year Economic Lifespan

Appendix C

Alternative 2D – Use Existing Sewer with Buried Ponding under Highway

Outfall Location

The outfalls for Alternative 2D are Almaz Pond and the expanded West Pond; both discharge to the Minnesota River near I-494. A flow splitting structure and diversion pipe would be constructed at the drop structure near Almaz Pond to direct roughly half the discharge to West Pond, in order to satisfy water quality storage requirements.

Conveyance System and Rate Control

Under Alternative 2D, the existing drainage system is utilized from Portland Avenue all the way to Almaz Pond; pipes upstream of Portland are replaced by larger pipe for increased capacity and to allow for the reduction in cover caused by the revised roadway profile.. Four new ponds are used to "shave" peaks in discharge and limit discharge to the conveyance capacity of the downstream system. In doing so, and by eliminating surcharging and flooding, Alternative 2D will reduce the overall discharge rate to the Minnesota River and exceed rate control requirements of the LMRWD. (The existing system surcharges and floods during both the 50- and 100-year events; see Wenck 2004, Appendix H.)

Sizing ponds and diversion structures for Alternative 2D was subject to constraints of high groundwater, a low road profile, and an undersized trunk sewer system. The pond bottom elevations were set at or above minimum groundwater elevations determined from groundwater monitoring data collected as part of this study (Wenck 2007d, Appendix H). The ground next to the highway is relatively high so that the normal pond elevations are 20 to 30 feet below grade. The 50-year maximum water levels were confined to the soffit elevation of the adjacent trunk sewer in order to meet the no-surcharge criterion. XP-SWMM model results were used to estimate the necessary pond. Storm sewer diversion devices and pond outlet discharge devices were sized and then tested with the assistance of the XP-SWMM model in an iterative process.

Ponds were not feasible at 24th and 12th Avenues because the groundwater was close to, or above the soffit of the trunk sewer pipe. Ponds were developed at Penn, Wentworth and Portland Avenues and at TH 77. The pond dimensions are summarized in Table C-1 and their designs are described below:

- **Penn Avenue Pond and Pump Station.** The Penn Avenue pump capacity is set as 3.5 cfs (1,600 gpm) to lift the 100-year runoff volume in 24-hours. The pump would deliver the flow to the trunk sewer at Colfax Avenue through a 4,000-ft, 15-inch force main. The pump would require a head of about 30 feet and a power of 11 kW. The pond is sized to work in conjunction with the pump to contain excess runoff to the Penn Avenue low point. (The final design might consider sizing the pond to contain the entire 6.9 ac-ft runoff from the 14.5-acre Penn Avenue drainage area without operation of the pump.) It was assumed that the existing pump station can be modified to accommodate the proposed lesser flow rates. Appropriate pump station design would include back up pumps.
- **Wentworth Avenue Pond.** The Wentworth pond works in parallel with the main trunk sewer ("offline") so that excess flows are diverted to the two pond areas, one on each side of the trunk sewer. Inflows to the low point are introduced to the system upstream of the pond diversion structure. An orifice in the trunk line restricts discharge in the downstream pipe and forces excess flow over weirs into the ponds. The ponds discharge through small diameter outlet pipes back to the trunk line, downstream of the orifice. A sump sediment trap would be constructed between the diversion weirs and the underground storage cells to prevent sediment from entering the storage cells where it would be difficult to remove.
- **Portland Avenue Pond.** The Portland Avenue pond accepts inflows from the upstream trunk sewer and the Portland Avenue low point. It works in parallel with the trunk line and is designed with the same conceptual layout as for Wentworth Pond.
- **TH 77 Pond.** The TH 77 pond accepts inflows from the upstream trunk sewer and from 12th Avenue and TH 77 low points. It works in parallel with the trunk line and is designed with the same conceptual layout as for Wentworth Pond.

Table C-1 Option 2D Existing Sewer with Buried Ponding under Highway

Pond Name/Location	**Penn Pond (Pumped)**	**Wentworth Pond**	**Portland Pond**	**TH 77 Pond**
Pond Dynamics	In-Series with Trunk Line	In-Series with Trunk Line	Flow not from Trunk Line	Flow not from Trunk Line
Contributing Watersheds	Penn	Colfax, Garfield, Pleasant, and Nicollet	Portland	12th Ave. and TH77
Peak 50-year Discharge Upstream of Pond				
Trunk Sewer (cfs)	85	330	94	195
Intervening Drainage to Low Point (cfs)	0	181	228	206
Pipe Invert Elevation at Pond Diversion Structure (ft)	811.8	811.5	805.1	799.0
Groundwater elevation (ft)	811.2	811.1	809.8	804.2
Mainline Orifice Downstream of Diversion				
Diameter (ft)	N/A	3.5	3.0	3.0
50-yr. peak discharge (cfs)	N/A	79	63	72
Pond Size (Total Area and Volumes)				
Pond Area (ac)	0.8	2 x 1.1 = 2.2	2 x 4.2 = 8.4	2 x 6.5 = 13
Pond Bottom Elevation (ft)	811.2	811.1	809.8	804.2
Peak Elevation (ft)	814.8	817.3	811.1	805.9
Bounce (ft)	3.6	6.2	1.3	1.7
Storage (ac-ft)	2.9	13.6	10.9	22.1
Total 50-year Storage for all Ponds (ac-ft)				49.5
Pond Inlet Weirs (two at each low point)				
Crest Length (ft)	N/A	2x18 = 36	2x30 = 60	2x40 = 80
Crest Elevation (ft)	N/A	814.5	809.8	804.2
50-year peak inflow (cfs)	N/A	2x217 = 434	2x120 = 240	2x158 = 316
Pond Outlet Pipes (two per pond)				
Diameter (RCP)	15”	12"	12"	12"
Length (ft)	4,000	50	50	50
50-year peak discharge (cfs)	3.5(pumped)	2x7.7 = 15	2x7.7 = 15	2x8.8 = 18
Mainline Pipe Downstream of Pond Outlets				
50-year peak discharge including pond discharge (cfs)	N/A	94	95	90
Pipe capacity (cfs)	N/A	169	177	263

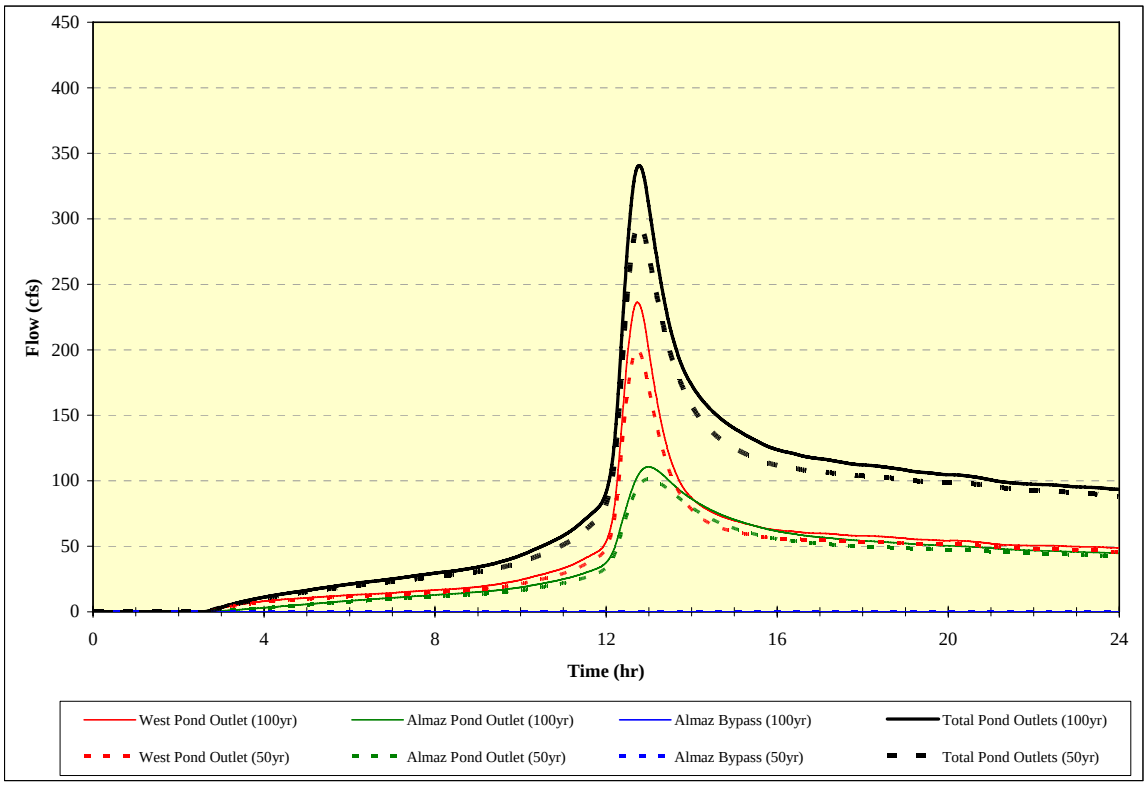
The pond storage cells are located under the highway near low points and are constructed of multiple 10 feet high by 14 feet wide pre-cast concrete box sections varying from 250 feet long at Penn to 1850 feet long at TH 77.

Alternative 2D meets the rate control requirements for the total system discharge rate (note that the total system peak flow rate is smaller than the sums of the individual locations due to the different times to peak; see Figure C-1):

Table C-2 Alternative 2D Peak Flow Rates (cfs)

Location	Rainfall Frequency	
	50-yr, 24-hr	**100-yr, 24-hr**
Total System	295	346
Almaz Outlet	101	111
Almaz Bypass	0	0
West Pond	200	236

The Alternative 2D discharge to the Minnesota River is shown in the combined hydrograph in Figure C-1 below.



Individual Outfall, and Combined Hydrographs for Alternative 2D Discharge to the Minnesota River

Figure C-1

Water Quality

Alternative 2D is hydraulically similar to 2C in that its conveyance pipes, diversion structures, pond areas and elevations are the same. Its sediment removal is also the same as for Alternative 2C. However, the two alternatives differ in that the buried ponding of Alternative 2D is less effective in phosphorus removal since there is no sunlight to allow growth and settling of algae, an important phosphorus sink in water quality ponds. Therefore, the ponds of Alternative 2D do not include dead storage volume.

The water quality detention volume of 52 ac-ft is substantially greater than the 19 ac-ft volume of Almaz pond so it is necessary to divert some of the discharge to Almaz pond. The flow would be split between Almaz pond and West Pond at a drop structure upstream of Almaz Pond. The diversion pipe would be 1,600 feet long and flow under the I-494 – TH 5 interchange over to the West Pond. The diversion would result in 30 ac-ft of the water quality detention volume being directed to West Pond and 22 ac-ft to Almaz pond. Since Almaz pond is somewhat overloaded, the dead storage volume of West Pond is increased to 33 ac-ft to achieve 50 percent removal. See Appendix H for details of the analysis.

The West Pond outlet to the Minnesota River was modeled as a 100-ft weir which resulted in a 0.9-ft bounce during the 100-year event. The weir was enlarged to minimize unintentional storage since the soils on the site are not adequate for the construction of berms. Detail design would address the exact outlet configuration with consideration for the effects of the discharge velocity on navigation and channel stability on the Minnesota River. See Appendix H for concerns raised about the outfall by the Lower Minnesota River Watershed District.

Sediment

Sediment from the I-494 drainage system would collect in the ponds, roughly in proportion to the flow volume entering each one. The total suspended sediment load for the I-494 drainage system is estimated as 400,000 lb/yr; this represents a total volume of roughly 5,000 ft^3/yr, or 2.3 ac-ft over a twenty–year period. (This is based on a typical total suspended solids concentration of 300 mg/L, and equivalent to about 900 lb/acre.) The sediment accumulation in Almaz and West ponds would reach about 0.9 and 1.2 acre-feet, respectively after 20 years of operation; these volumes correspond to average sediment depths of 0.3 feet and 0.2 feet, respectively.

Approximately 0.2 ac-ft would accumulate in the underground ponds over the same 20-year period. The relatively small portion is due to the configuration of the pond diversion/inlet designs. Storms less than about 0.7 inches would not activate the underground pond storage, and even for larger events only a portion of the total discharge volume would enter the ponds. Due to the distribution of storm event depths, about 10 to 15 percent of the inflow at Wentworth, Portland and TH 77 ponds enters the ponds. A sump sediment trap would be constructed between each of the diversion weirs and the underground storage cells to prevent sediment from entering the storage cells where it would be difficult to remove. The volume of each is estimated as the weir length times the width of three concrete box sections and a five-foot sump depth. Sump volumes sized this way will be sufficient to store sediment for more than twenty years.

Maintenance

As per the sedimentation discussion in Section 3, even though Mn/DOT does not use sand for snow and ice control along this section of highway, the accumulation of sediment still occurs. This material finds its way to the site on the tires of vehicles entering from sandy areas, as wind blown debris from off site, or from open topped loads of sand and aggregate that traverse the highway.

Regardless of the drainage Alternative selected, the total amount of sediment generated over the 438 acre site will remain constant. This is estimated at 4,468 cubic feet of material each year. Although a consistent street sweeping program can capture half of this material, our estimates assume that all suspended solids are conveyed to the storm sewer system.

For Alternatives 2D, which reuses the existing storm sewer system, catch basins at each storm sewer intake location will capture a large portion of the suspended solids. Further downstream, the control structures associated with each of the four ponds will be designed such that the majority of low flows will bypass the ponds altogether, carrying suspended solids to Almaz Pond. Under larger events, each detention basin in the system will be expected to capture a portion of the remaining annual sediment load (see Sediment section above).

Our assumption is that Almaz Pond, and the four ponds at Penn, Wentworth, Portland, and TH 77, will be cleaned of accumulated sediment every ten years. As with other existing detention basins, cleaning of Almaz Pond will occur during the winter, when water levels are low and access by tracked excavators and dump trucks can be made over frozen ground.

We have further assumed that 20% of the individual catch basins will be cleaned each year. Both the catch basins and the buried storage facilities will be cleaned of accumulated sediment through the use of purpose built vacuum trucks, accompanied by necessary and required support vehicles and traffic control.

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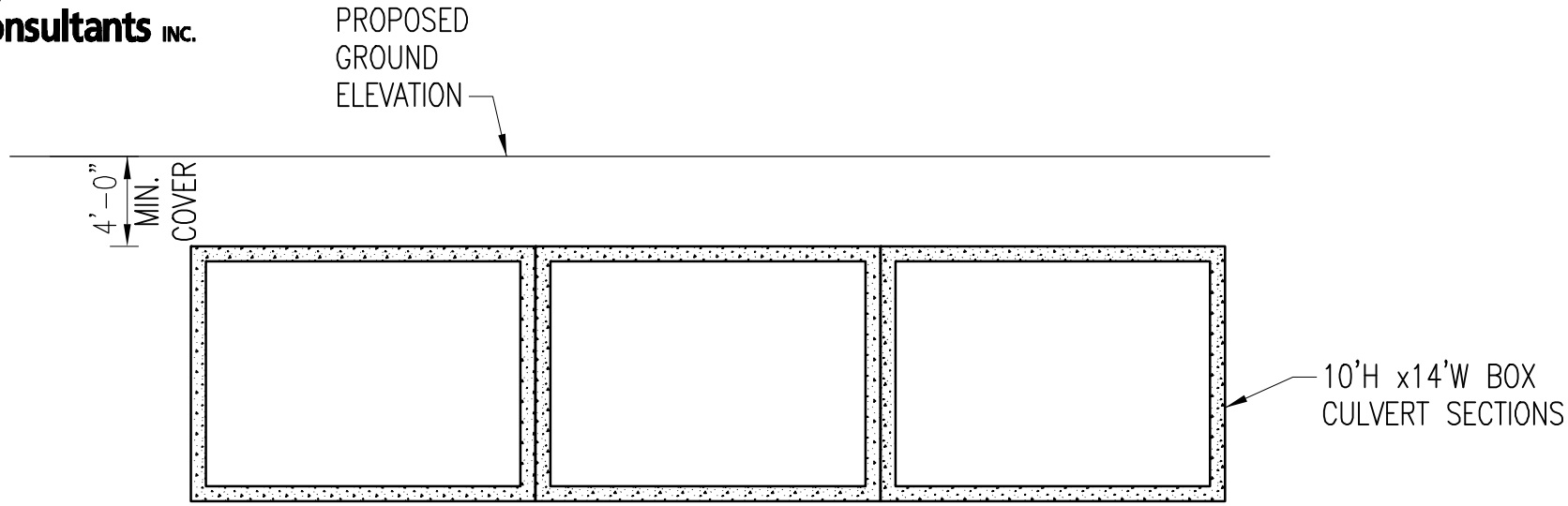

LOCATION	PROPOSED GROUND ELEVATION	GROUNDWATER TABLE	EXISTING SYSTEM INVERT	BOUNCE (ft)
PENN AVE.	826.10	811.2	811.8	3.6
WENTWORTH AVE.	826.60	811.1	811.5	6.2
PORTLAND AVE.	825.30	809.8	805.1	1.3
TH 77	826.90	804.2	799.0	1.7

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FIGURE C–2
BURIED STORAGE (CULVERT)
I–494 STORMWATER ALTERNATIVES STUDY

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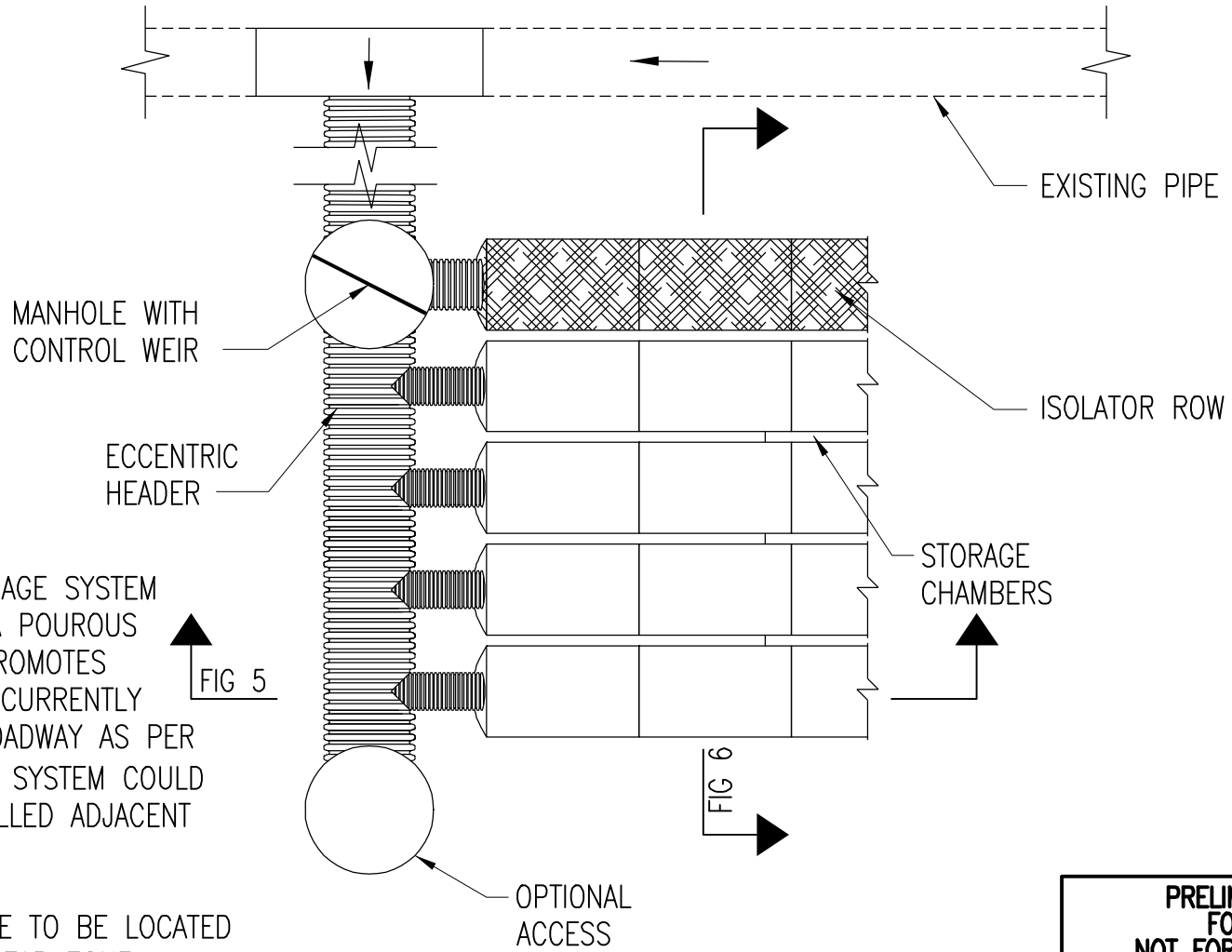

NOTES:

1. THIS DETENTION STORAGE SYSTEM ASSUMES THE USE OF A POUROUS BACKFILL. WHILE THIS PROMOTES INFILTRATION, IT IS NOT CURRENTLY ALLOWED UNDER THE ROADWAY AS PER Mn/DOT. AS SUCH, THIS SYSTEM COULD ONLY BE USED IF INSTALLED ADJACENT TO THE ROADWAY.

2. ACCESS AND MANHOLE TO BE LOCATED WITHIN SHOULDER OF CLEAR ZONE.

3. CHAMBER LENGTH VARIES 500'–1500' (+/–)

SOURCE: STORMTECH

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FIGURE C–3
BURIED STORAGE PLAN (HDPE OPTION)
I–494 STORMWATER ALTERNATIVES STUDY

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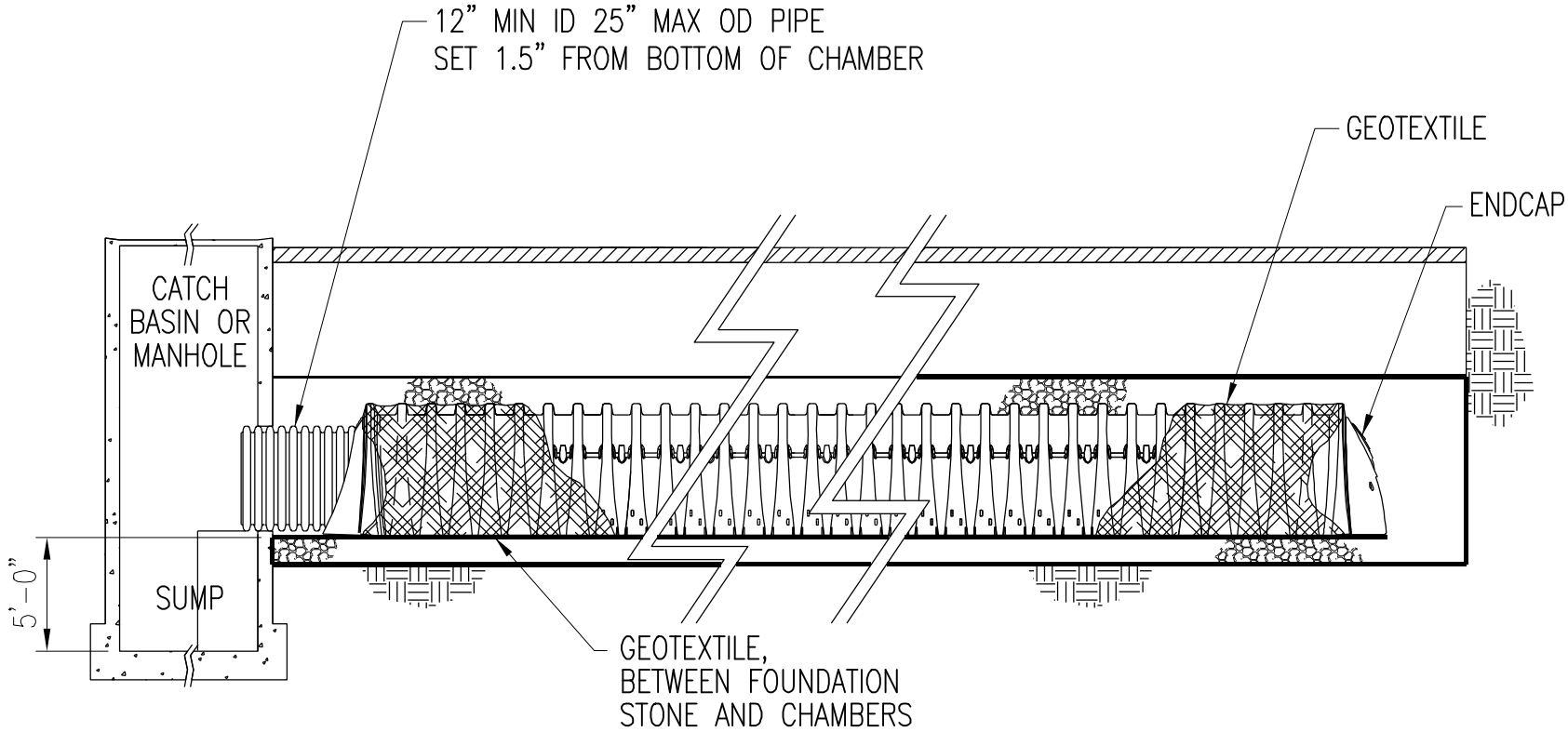

NOTE:

1. SEE FIGURE 04 FOR NOTES

SOURCE: STORMTECH

FIGURE C–4
BURIED STORAGE SECTION (HDPE OPTION)
I–494 STORMWATER ALTERNATIVES STUDY

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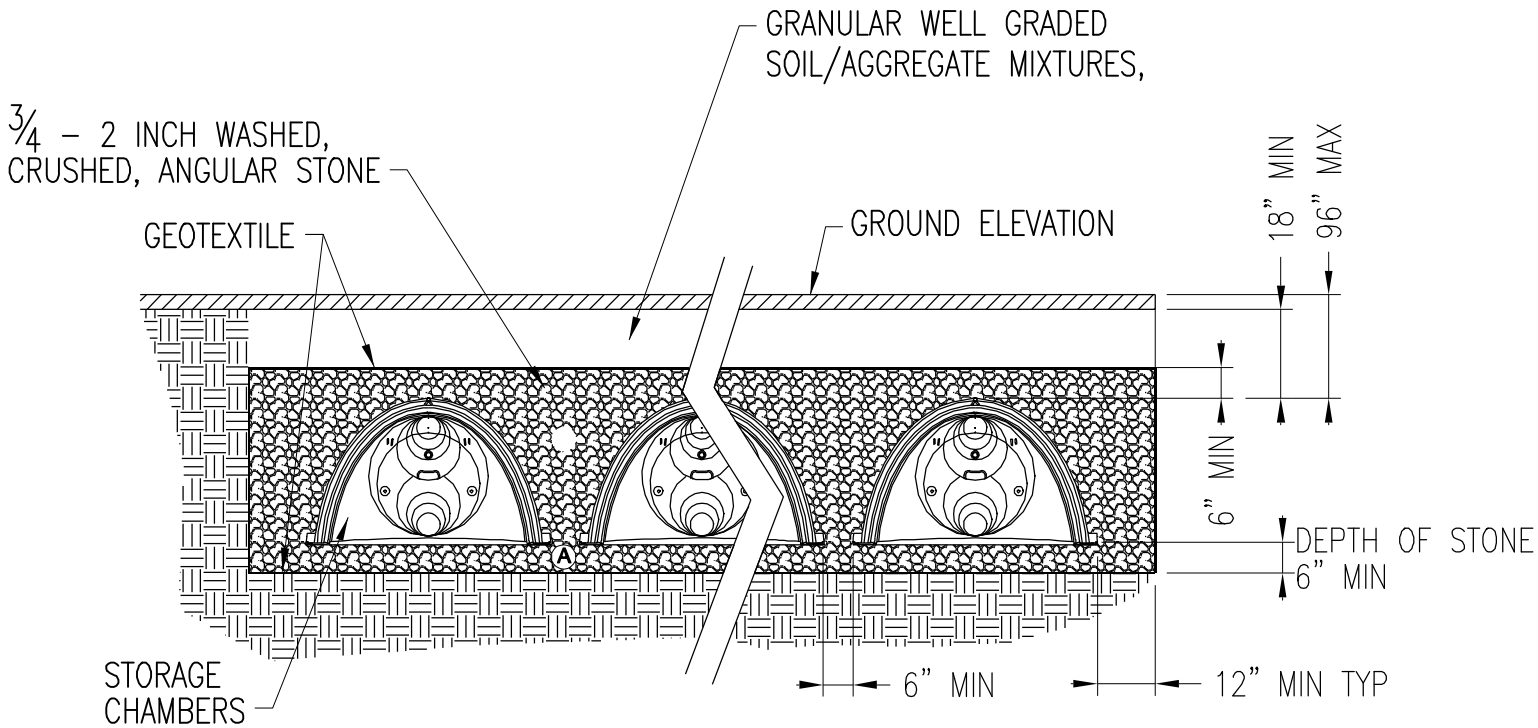

NOTE:

1. SEE FIGURE 04 FOR NOTES.

LOCATION	GROUND ELEVATION	GROUNDWATER TABLE	EXISTING SYSTEM INVERT	BOUNCE (ft)
PENN AVE.	830	811.2	811.8	3.6
WENTWORTH AVE.	840	811.1	811.5	6.2
PORTLAND AVE.	830	809.8	805.1	1.3
TH 77	825	804.2	799.0	1.7

**PRELIMINARY ISSUE
FOR REVIEW
NOT FOR CONSTRUCTION**

**FIGURE C–5
BURIED STORAGE SECTION (HDPE OPTION)
I–494 STORMWATER ALTERNATIVES STUDY**

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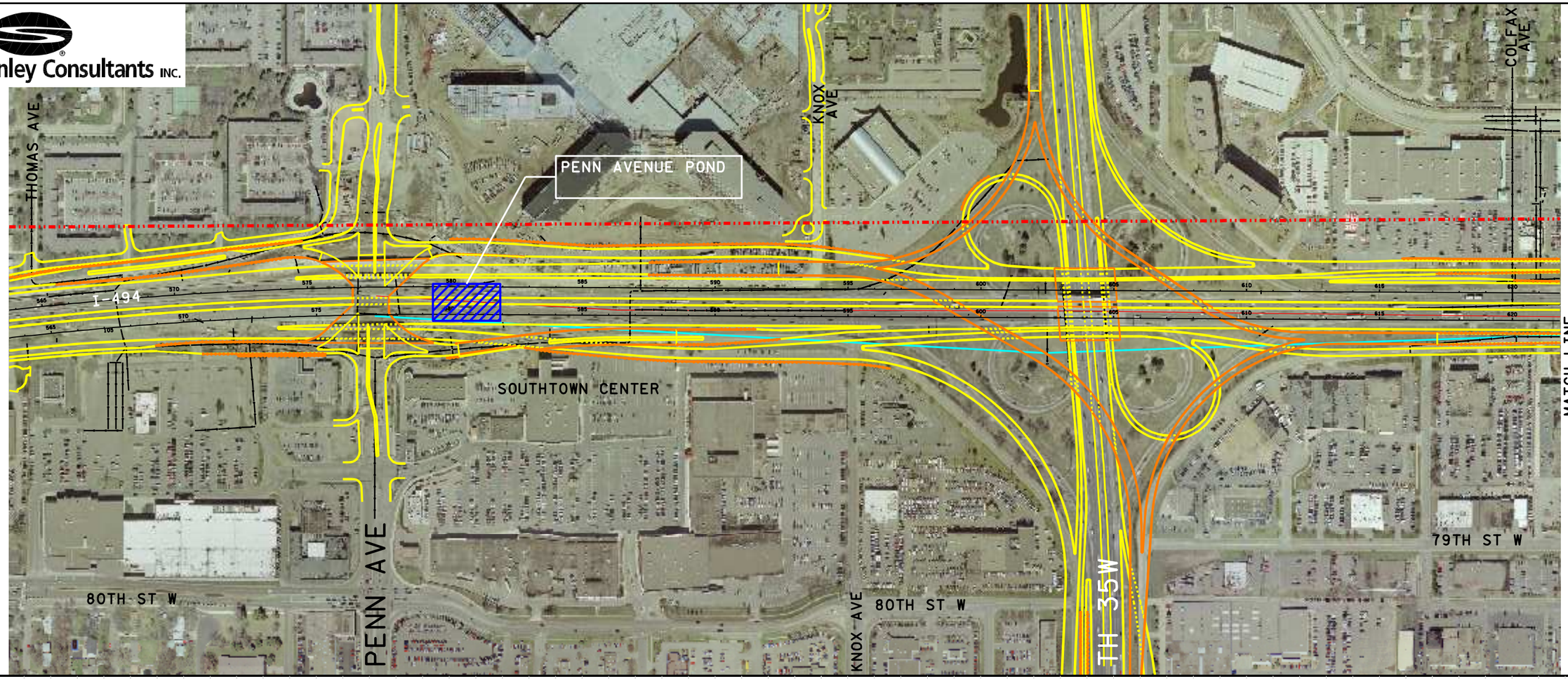

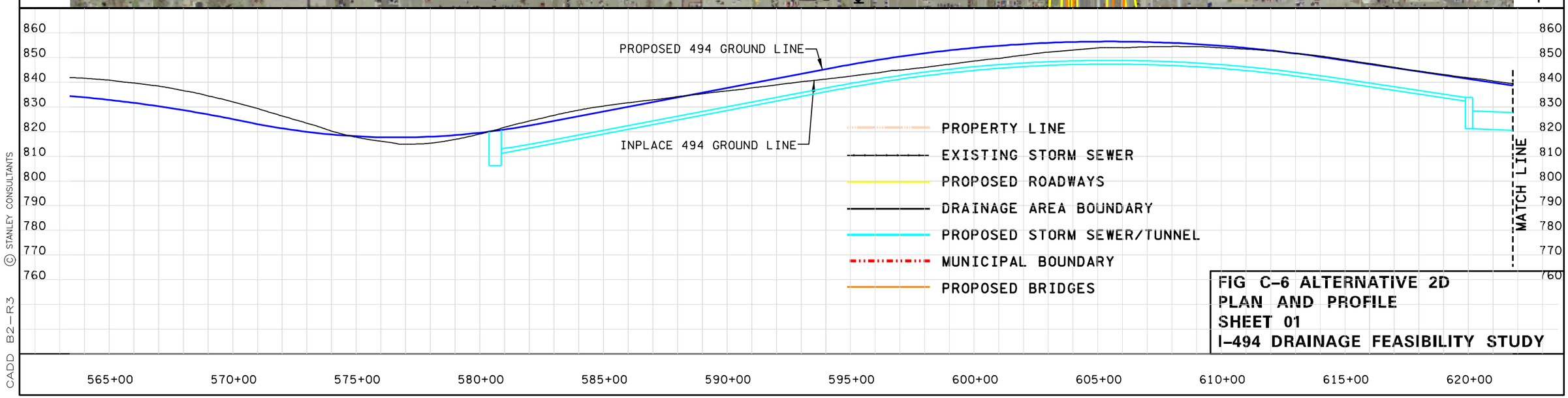

FIG C-6 ALTERNATIVE 2D
PLAN AND PROFILE
SHEET 01
I-494 DRAINAGE FEASIBILITY STUDY

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CADD B2-R3

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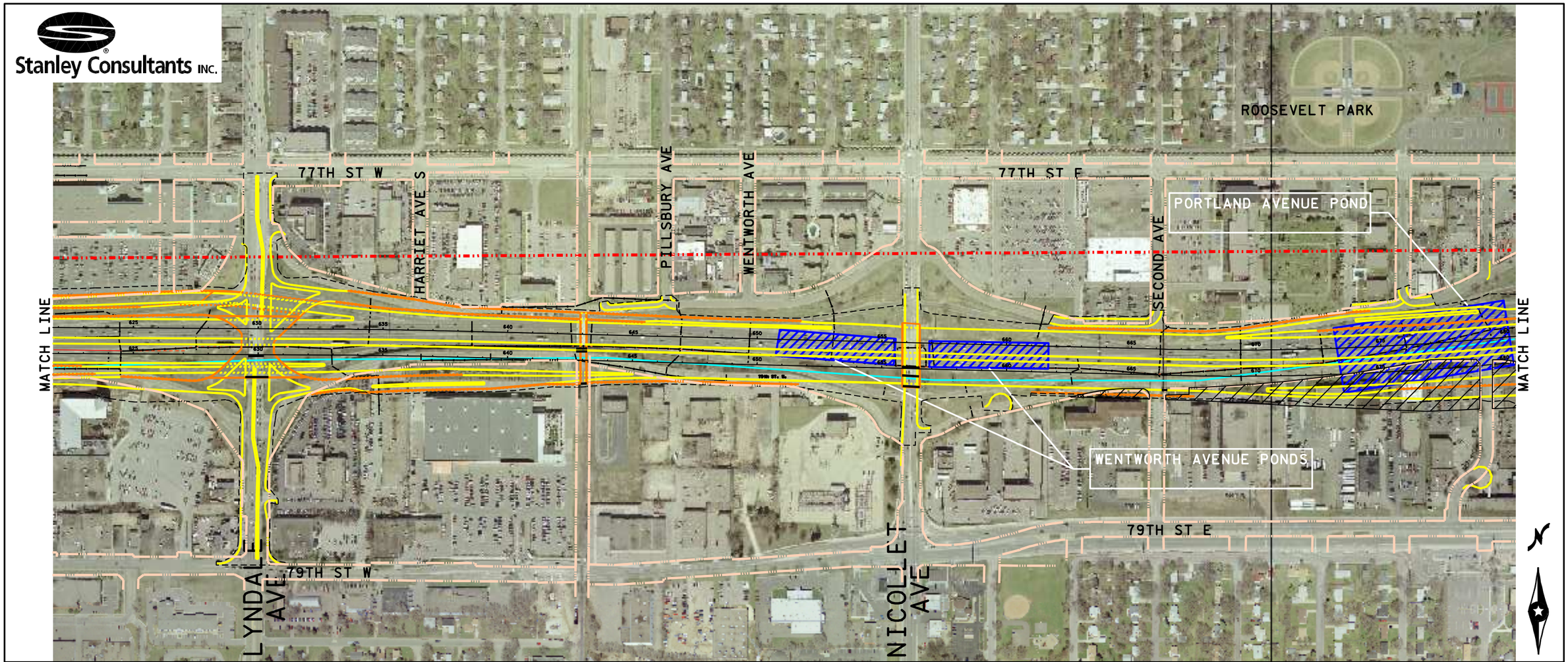

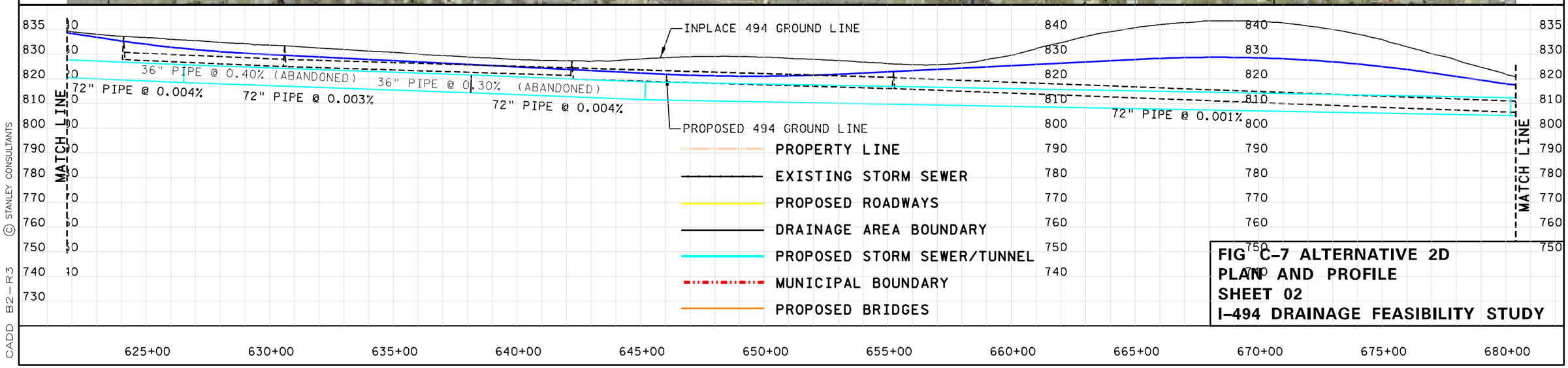

FIG C-7 ALTERNATIVE 2D
PLAN AND PROFILE
SHEET 02
I-494 DRAINAGE FEASIBILITY STUDY

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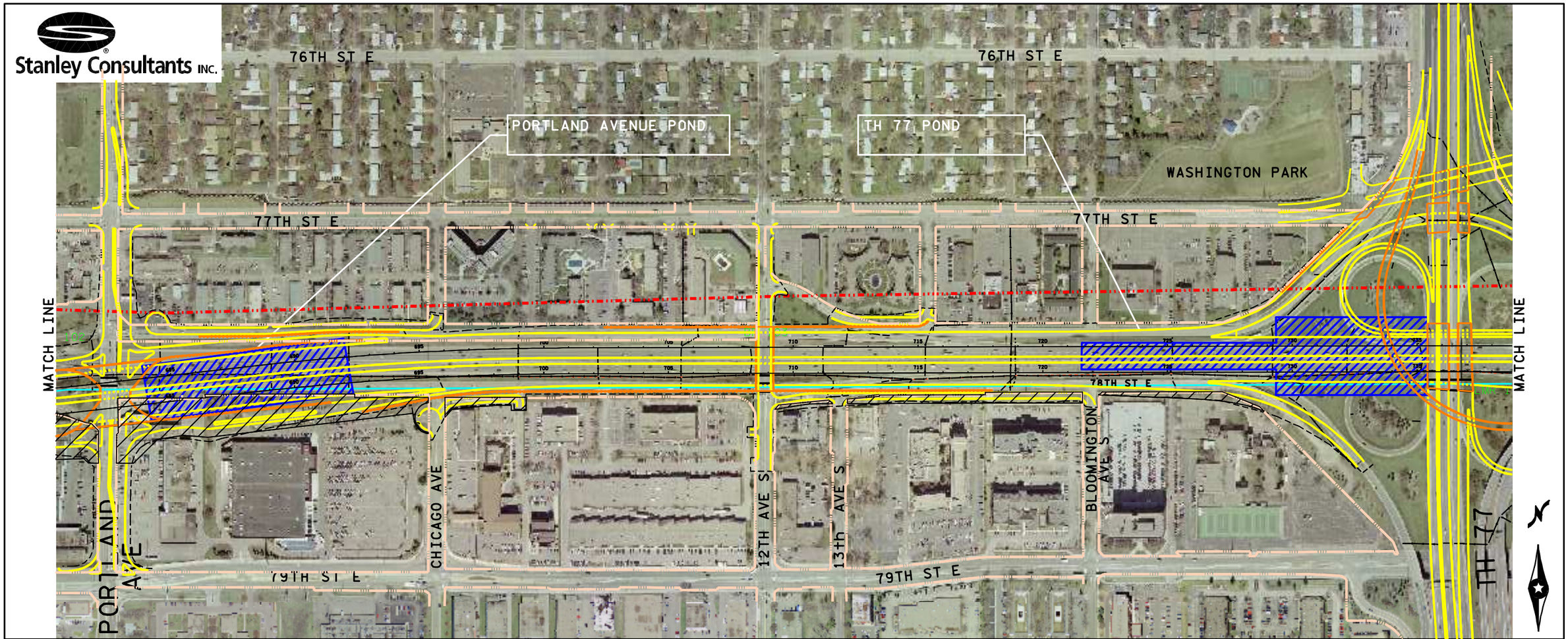

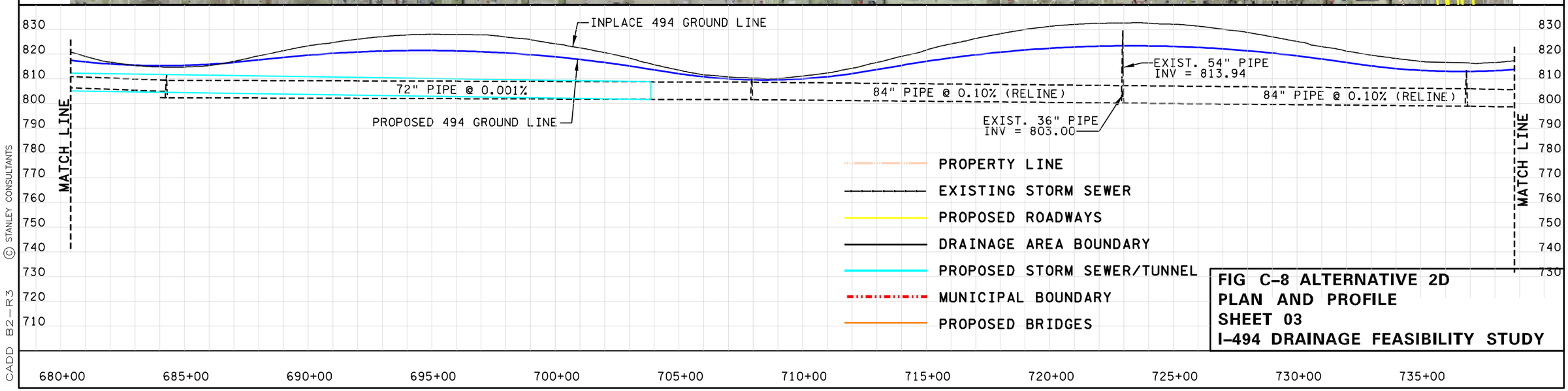

FIG C-8 ALTERNATIVE 2D
PLAN AND PROFILE
SHEET 03
I-494 DRAINAGE FEASIBILITY STUDY

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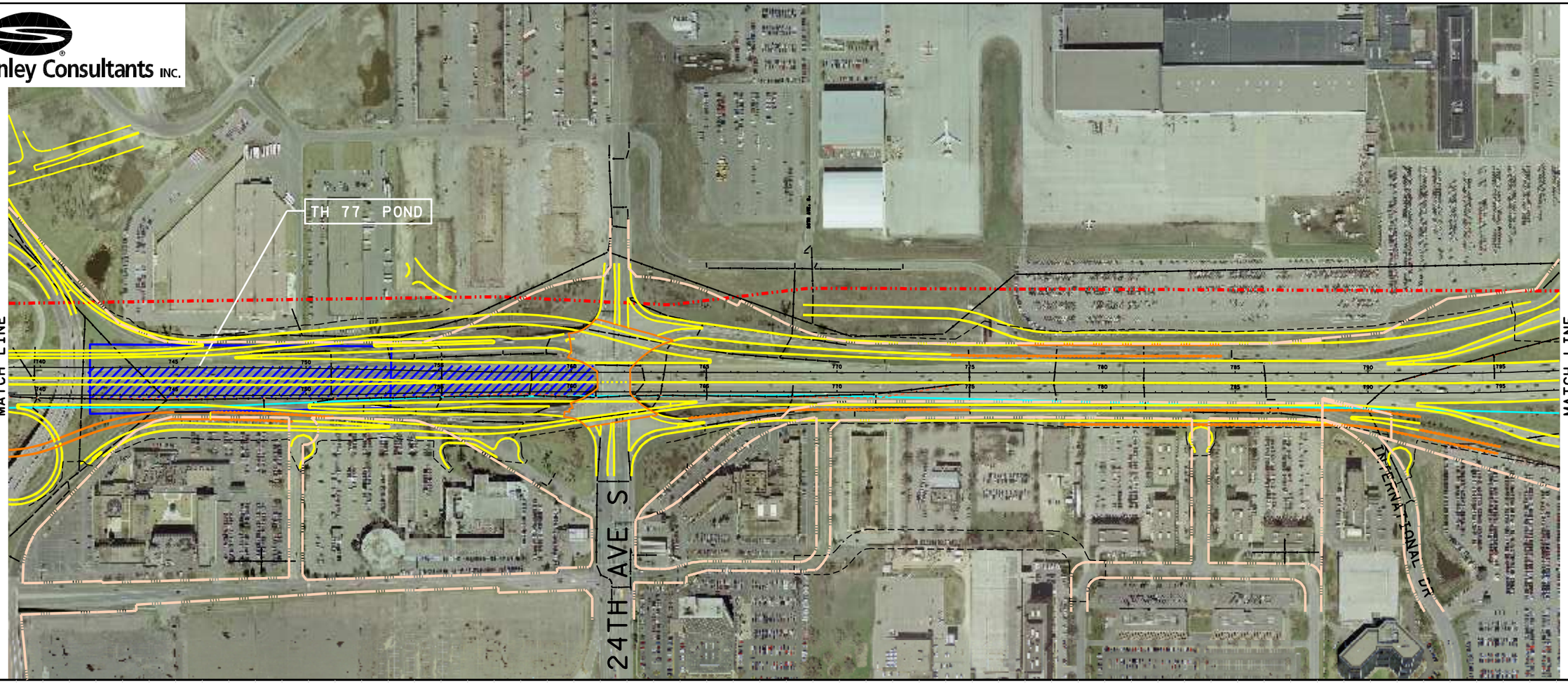

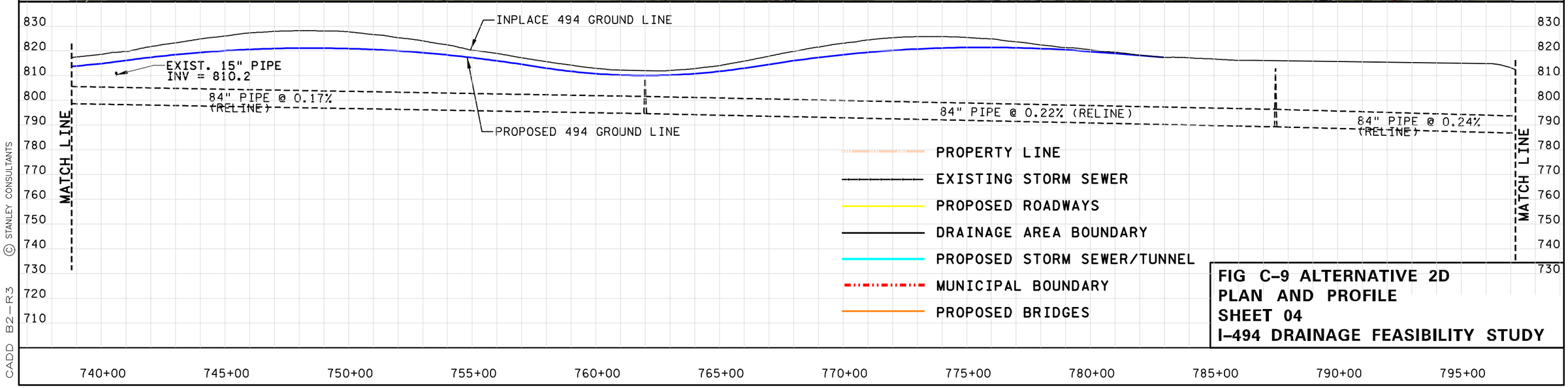

FIG C-9 ALTERNATIVE 2D
PLAN AND PROFILE
SHEET 04
I-494 DRAINAGE FEASIBILITY STUDY

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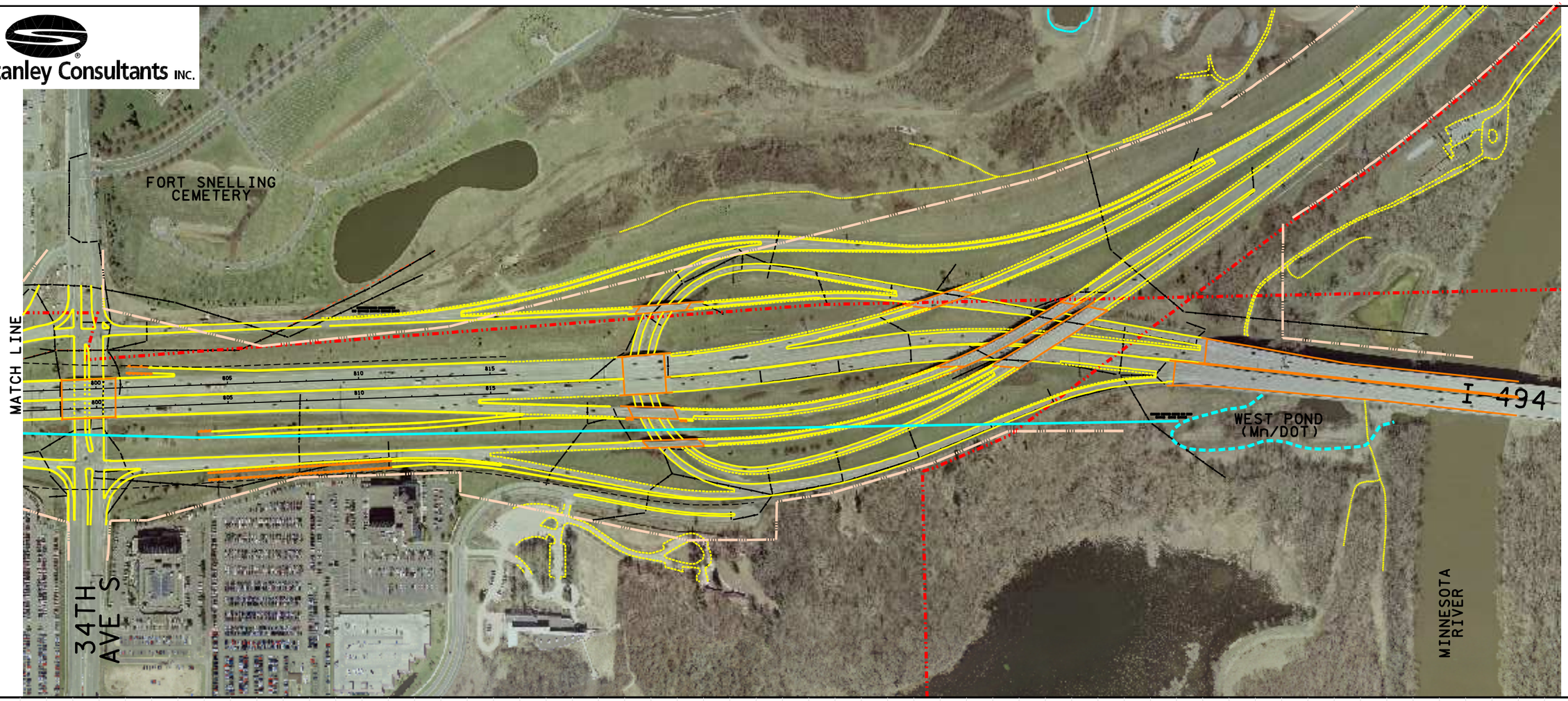

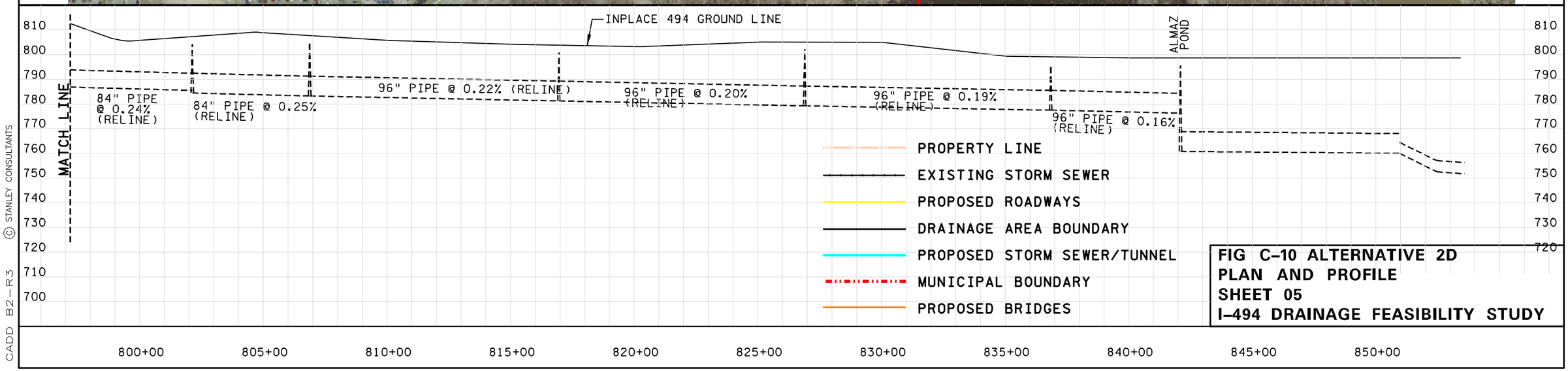

FIG C–10 ALTERNATIVE 2D
PLAN AND PROFILE
SHEET 05
I–494 DRAINAGE FEASIBILITY STUDY

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CADD B2–R3

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 2D	**Existing Sewer with Buried Storage**	Expensive land[21]	x	x			
	Rehabilitate and reuse the in place storm sewer. Provide detention storage in storage cells placed beneath the highway.	Meets water quality standards			x		x
		West pond can handle the water					x
		Decision needed soon[10]	x				
		Provide all needed sediment and phosphorus removal					x
	Ponding at Penn, Wentworth, Portland, and TH 77	Possibly pump water to Wood Lake		x			
	Penn Ave stormwater will be pumped	Use a tunnel from Penn to Lyndale and then ponds east of Lyndale		x			
	Pipes upstream of Portland are replaced	Water can drain into Almaz (state pond)					x
	Uses West Pond & Almaz Pond for water quality	Additional space may be available for underground storage[9]	x				
		Richfield has many older sites in need of redevelopment	x				
	Ponding is buried under roadway for detention storage only.	More land needed[19]			x		
		Ponds 20 feet below ground					x
		Restricted by pipe capacity[20]					x
		Resistance from Cities[8]	x	x			
		Lower MN Watershed permit required				x	
		Existing system does not cover entire corridor					x
		Pond locations subject to change	x	x			
		Maintenance component to upstream sediment basins	x				x
		Economical loss[22]	x	x			
		Existing pipe deterioration					x
		Existing pipe relining					x
		Do not currently use underpavement storage					x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION	STAKEHOLDER CONCERNS				
	This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT

Notes:

1. Water could still be taken down to the river and treated at those ponds.
2. Met water quality standard.
3. Based on the same information as Mn/DOT.
4. The pumps would go into the new system and would not need to be programmed on a hydrograph schedule.
5. These possibilities include: remote control vehicles, future technology, better street sweeping to prevent build up of sediment in the tunnel, and stormcepters.
6. This is already an expensive project. Even if the tunnel ends up costing more, it may be worth the extra expense to avoid having to acquire more land.
7. The City of Bloomington has a much shorter timeframe than Mn/DOT, and needs to provide funding
8. Massive political problems (Richfield's land use plan is already done).
9. This space is located in Bloomington by 24th and I-494 by the airport.
10. Because of all the current construction in these areas, the Cities need to know what land the ponds will be built on so they can to help protect this land.
11. It is needed for longer term detention downstream.
12. This assumes peak flow is allowed without detention.
13. Sediment may get into the tunnel and than it will need to be removed.
14. The tunnel is more difficult to clean out then the surface ponds.
15. Maintenance costs and techniques for buried storage of this magnitude are difficult to calculate because of the lack of existing comparable systems.
16. Not used.
17. Rate control standards are not met.
18. The ponds in Bloomington that are located below the bluff are currently not meeting capacity and need maintenance.
19. This includes land beyond the ROW.
20. This leads to flooding at the low points along the corridor.
21. Richfield would double the property cost listed on the Hennepin County Assessor's site.
22. The combination of cost and disruption to the Cities is very high.

CONCEPTUAL COST ESTIMATE
I-494 STORMWATER ALTERNATIVES STUDY

Apr-07

PRE-CONSTRUCTION - ENGINEERING AND DESIGN	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES - INITIAL CONSTRUCTION	TOTAL ESTIMATED COST - INITIAL CONSTRUCTION	TOTAL ESTIMATED QUANTITIES - RECONSTRUCTION	TOTAL ESTIMATED COST - RECONSTRUCTION
			2D	2D	2D	2D
ENGINEERING AND DESIGN		VARIES	12.00%	$13,422,693.60	12.00%	$3,306,395.28
Assume a set percentage of the construction cost, less right-of-way and acquisition						
				$13,422,693.60		$3,306,395.28

PRE-CONSTRUCTION - RIGHT-OF-WAY	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
			2D	2D	2D	2D
RIGHT OF WAY and EASEMENTS	LUMP SUM	VARIES	$3,074.49	$3,074.49	$0.00	$0.00
RELOCATION and REESTABLISHMENT	LUMP SUM	VARIES	$0.00	$0.00	$0.00	$0.00
PAVEMENT REMOVAL and DEMOLITION	LUMP SUM	VARIES	$0.00	$0.00	$0.00	$0.00
				$3,074.49		$0.00

CONSTRUCTION - PHYSICAL CONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
RCP STORM SEWER, 36" DIAMETER (surface drainage system excluded)	2503.511/02035	LF	$85.00	200	$0.00
RCP STORM SEWER, 48" DIAMETER (surface drainage system excluded)	2503.511/02048	LF	$95.00	0	$0.00
RCP STORM SEWER, 60" DIAMETER (surface drainage system excluded)	2503.511/02060	LF	$110.00	0	$0.00
RCP STORM SEWER, 72" DIAMETER (surface drainage system excluded)	2503.511/02072	LF	$150.00	6018	$0.00
			$220.00		
TUNNEL, 120" DIAMETER		LF	$0.00	0	$0.00
TUNNEL, 144" DIAMETER		LF	$3,500.00	0	$0.00
TUNNEL SHAFT HOLES		EACH	$205,000.00	0	$0.00
PORTAL WORK SITE		EACH	$115,000.00	0	$0.00
DEWATERING (with tunnel alternatives only)		LUMP SUM	$115,000.00	0	$0.00
MINING TUNNEL, 42" DIAMETER		500' UNITS	$20,000.00	10	$200,000.00
MICROTUNNEL ACCESS SHAFTS (every 1500')		LF	$1,000.00	0	$0.00
		EACH	$115,000.00	0	$0.00
FORCE MAIN, 15" STEEL	2504.503/02015	LF	$60.00	4000	$240,000.00
CATCH BASIN (ADDITIONAL DEPTH OF DRAINAGE STRUCTURE)	2506.501/00910				
RESURFACE TEMPORARY ACCESS LOCATIONS, 8"	2360.501/22000	LF	$360.00	700	$0.00
		SF	$2.00	0	$0.00
REHABILITATE STORM SEWER, 27" DIAMETER		LF	$90.00	801	$16,020.00
REHABILITATE STORM SEWER, 36" DIAMETER		LF	$100.00	0	$0.00
REHABILITATE STORM SEWER, 48" DIAMETER		LF	$40.00	0	$0.00
REHABILITATE STORM SEWER, 60" DIAMETER		LF	$50.00	0	$0.00
REHABILITATE STORM SEWER, 72" DIAMETER		LF	$60.00	0	$0.00
REHABILITATE STORM SEWER, 84" DIAMETER		LF	$70.00	0	$0.00
REHABILITATE STORM SEWER, 96" DIAMETER		LF	$80.00	11921	$953,680.00
		LF	$90.00	2485	$223,650.00
POND LOCATION NUMBER 1, PENN AVENUE					
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	18000	$144,000.00
TURF ESTABLISHMENT		ACRE	$5,000.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	0	$0.00
10H X 14W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	2460	$2,706,000.00
HOPE LINER (to seal behind groundwater infiltration)		LINEAR FOOT	$220.00	0	$0.00
HOPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	2401.501/03831	CUBIC YARD	$250.00	310	$77,500.00
CONTROL STRUCTURE (Structural Concrete)	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00
RETAINING WALL					
POND LOCATION NUMBER 2, WENTWORTH AVENUE					
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	40200	$322,000.00
TURF ESTABLISHMENT		ACRE	$5,000.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	0	$0.00
10H X 14W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	1710	$1,881,000.00
HOPE DETENTION STORAGE CELLS (Box Culvert Equivalent)		LINEAR FOOT	$220.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03831	CUBIC YARD	$250.00	190	$47,500.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00
POND LOCATION NUMBER 3, PORTLAND AVENUE					
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	185000	$1,480,000.00
TURF ESTABLISHMENT		ACRE	$5,000.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	0	$0.00
10H X 14W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	6540	$7,194,000.00
HOPE LINER (to seal behind groundwater infiltration)		SQUARE FOOT	$3.00	0	$0.00
HOPE DETENTION STORAGE CELLS (Box Culvert Equivalent)		LINEAR FOOT	$220.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03831	CUBIC YARD	$250.00	290	$72,500.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00
POND LOCATION NUMBER 4, TH77					
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$5,000.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	0	$0.00
10H X 14W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	10110	$11,121,000.00
HOPE LINER (to seal behind groundwater infiltration)		SQUARE FOOT	$3.00	0	$0.00
HOPE DETENTION STORAGE CELLS (Box Culvert Equivalent)		LINEAR FOOT	$220.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03831	CUBIC YARD	$250.00	360	$90,000.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00
WEST POND EXPANSION (Or new pond for Alternative 4A)					
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$5,000.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03831	CUBIC YARD	$250.00	20	$5,000.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	4950	$173,250.00
PUMP STATION, 3.5 CFS		LUMP SUM	$100,000.00	0	$0.00
SUBTOTAL					$22,960,670.00
CONTINGENCY			20.00%		$4,592,134.00
					$27,553,044.00

CONSTRUCTION - CONSTRUCTION MANAGEMENT	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
CONSTRUCTION MANAGEMENT		VARIES	9.00%	$5,592,789.00	$1,377,652.20
Assume a set percentage of the construction cost, less right-of-way and acquisition					
				$5,592,789.00	$1,377,652.20

POST-CONSTRUCTION - MAINTENANCE	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
MAINTENANCE		LUMP SUM	1	$719,000.00	0	$0.00
Present value of an annual sum						
				$719,000.00		$0.00

TOTAL PROJECT COST, INITIAL CONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED COST, YEAR 40	TOTAL ESTIMATED COST, PRESENT VALUE OF YEAR 40 CONSTRUCTION
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$13,422,693.60		$4,776,167.42
PRE-CONSTRUCTION - RIGHT-OF-WAY				$3,074.49		$0.00
CONSTRUCTION - PHYSICAL CONSTRUCTION				$111,855,780.00		$39,801,395.13
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$5,592,789.00		$1,990,069.78
POST-CONSTRUCTION - MAINTENANCE				$719,000.00		$0.00
				$131,593,337.09		$46,567,632.31

TOTAL PROJECT COST, YEAR 40 RECONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED COST, PRESENT VALUE OF YEAR 40 CONSTRUCTION
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$4,776,167.42
PRE-CONSTRUCTION - RIGHT-OF-WAY				$0.00
CONSTRUCTION - PHYSICAL CONSTRUCTION				$39,801,395.13
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$1,990,069.78
POST-CONSTRUCTION - MAINTENANCE				$0.00
				$46,567,632.31

TOTAL PROJECT COST, 80-YEAR LIFE CYCLE, 2007 DOLLARS	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$16,198,861.02
PRE-CONSTRUCTION - RIGHT-OF-WAY				$3,074.49
CONSTRUCTION - PHYSICAL CONSTRUCTION				$151,657,175.13
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$7,582,858.78
POST-CONSTRUCTION - MAINTENANCE				$719,000.00
				$176,160,969.40

MAINTENANCE COSTS
I-494 STORMWATER ALTERNATIVES STUDY

ALTERNATIVE	1C	2C	2D	2E	2F	4A	5A
SEDIMENT ACCUMULATION	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)
PENN		3300	3300	3300	3300		
WENTWORTH		26500	2100	2100	2100		
PORTLAND		10000	1400	1400	1400		
TH 77		29100	3800	3800	3800		
ALMAZ POND	26100	31300	89600	89600	89600	74100	26100
WEST POND	74100	0	0	0	0	26100	74100
	100200	100200	100200	100200	100200	100200	100200
20-year volume [ac-ft]	2.30	2.30	2.30	2.30	2.30	2.30	2.30

SEDIMENT COLLECTION

Use upstream catch basins to collect sediment prior to entry into mainline storm sewer *

Number of Intakes, EA	175	175	175	175	175	175	525
Additional height per intake, FT	4	4	4	4	4	4	4
Assumed height of additional intakes, FT	700	700	700	700	700	700	2100
At 6' diameter, provided storage per unit, CF	113	113	113	113	113	113	113
Total Intake Storage Provided, CF	19775	19775	19775	19775	19775	19775	59325
Total Intake Storage Provided, CY	732	732	732	732	732	732	2197
Catch basin volume [ac-ft]	0.45	0.45	0.45	0.45	0.45	0.45	1.36

* Assume equivalent distribution over each ponding area

Sediment to be removed from sumps **

PENN		2475	2475	2475	2475		
WENTWORTH		19875	1575	1575	1575		
PORTLAND		7500	1050	1050	1050		
TH 77		21825	2850	2850	2850		
ALMAZ POND	19575	23475	67200	67200	67200	55575	19575
WEST POND	55575					19575	55575

** Assume 25% of sediment is captured in the catch basins

20-year volume to Ponds	1.73	1.73	1.73	1.73	1.73	1.73	1.73
20-year volume to Catch Basins	0.58	0.58	0.58	0.58	0.58	0.58	0.58
20-year volume total	2.30	2.30	2.30	2.30	2.30	2.30	2.30

Maintenance Assumptions

Catch Basins

20% Intakes cleaned annually
6,262.50 Sediment Cleaned Annually from sumps
6 Intakes per hour per crew
5.83 Crew Hours, say 8 hours
$ 2,000.00 Cost per hour per crew, including traffic control
$ 2.55 per cubic foot removed
$ 68.98 per cubic yard removed from Catch Basins
$ 16,000.00 say $ 20,000.00 per year

Ponds and Sumps Clean 20% of sumps annually
$ 137.96 Cost per yard removed from Sumps
$ 68.98 Cost per yard removed from Ponds

PENN		$	1,264.67	$	2,529.34	$	2,529.34	$	2,529.34			$	-
WENTWORTH		$	10,155.69	$	1,609.58	$	1,609.58	$	1,609.58			$	-
PORTLAND		$	3,832.34	$	1,073.05	$	1,073.05	$	1,073.05			$	-
TH 77		$	11,152.10	$	2,912.57	$	2,912.57	$	2,912.57			$	-

West Pond Clean every 10 years
$ 68.98 per cubic yard removed from Ponds

ALMAZ POND	$	2,500.60	$	2,998.80	$	8,584.43	$	8,584.43	$	8,584.43	$	7,099.40	$	2,500.60
WEST POND (I-35W OUTLET POND)	$	7,099.40	$	-	$	-	$	-	$	-	$	2,500.60	$	7,099.40

SEDIMENT LOCATION	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST
INTAKES/CATCH BASINS	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 60,000.00
PENN	$ -	$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34	$ -	$ -
WENTWORTH	$ -	$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58	$ -	$ -
PORTLAND	$ -	$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05	$ -	$ -
TH 77	$ -	$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57	$ -	$ -
ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
OUTLET POND	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40
ANNUAL TOTAL	$ 29,600.00	$ 49,403.59	$ 36,708.98	$ 36,708.98	$ 36,708.98	$ 29,600.00	$ 69,600.00
PRESENT VALUE	$ 580,000.00	$ 968,000.00	$ 719,000.00	$ 719,000.00	$ 719,000.00	$ 580,000.00	$ 1,364,000.00

5% Inflation Rate
80 Year Economic Lifespan

Appendix D

Alternative 2E – Existing Sewer with Modified Adjacent and Under Roadway Ponding

Outfall Location

The outfalls for Alternative 2E are Almaz Pond and the expanded West Pond; both discharge to the Minnesota River near I-494. A flow splitting structure and diversion pipe would be constructed at the drop structure near Almaz Pond to direct roughly half the discharge to West Pond, in order to satisfy water quality storage requirements.

Conveyance System and Rate Control

This alternative is based upon Alternatives 2C and 2D with the changes primarily in the configuration and physical location of the four stormwater ponds. As above, ponds (storage facilities) will be needed at Penn, Wentworth, Portland, and TH77. The intent of this alternative was twofold. First, the ponds and storage cells were to minimize the amount of private property required to provide detention storage. Second, the use of storage cells within the highway right-of-way and directly under the mainline roadway pavement should be minimized to reduce construction impacts or disruption to traffic during maintenance activities.

Under Alternative 2E, the existing drainage system is utilized from Portland Avenue all the way to Almaz Pond; pipes upstream of Portland are replaced by larger pipes for increased capacity and to allow for the reduction in cover caused by the revised roadway profile.. Four new ponds are used to "shave" peaks in discharge and limit discharge to the conveyance capacity of the downstream system. In doing so, and by eliminating surcharging and flooding, Alternative 2E, as with Alternative 2D, will reduce the overall discharge rate to the Minnesota River and exceed rate control requirements of the LMRWD. (The existing system surcharges and floods during both the 50- and 100-year events; see Wenck 2004, Appendix H.)

Sizing ponds and diversion structures for Alternative 2E was subject to constraints of high groundwater, a low road profile, and an undersized trunk sewer system. The pond bottom elevations were set at or above minimum groundwater elevations determined from groundwater monitoring data collected as part of this study (Wenck 2007d, Appendix H). The ground next to the highway is relatively high so that the normal pond elevations are 20 to 30 feet below grade. The 50-year maximum water levels were confined to the soffit elevation of the adjacent trunk sewer in order to meet the no-surcharge criterion. XP-SWMM model results were used to estimate the necessary pond. Storm sewer diversion devices and pond outlet discharge devices were sized and then tested with the assistance of the XP-SWMM model in an iterative process.

Ponds were not feasible at 24th and 12th Avenues because the groundwater was close to, or exceeded the soffit of the trunk sewer pipe. Ponds were developed at Penn, Wentworth and Portland Avenues and at TH 77. The pond dimensions are summarized in Table D-1 and their designs are described below:

- **Penn Avenue Pond and Pump Station.** The Penn Avenue pump capacity is set as 3.5 cfs (1,600 gpm) to lift the 100-year runoff volume in 24-hours. The pump would deliver the flow to the trunk sewer at Colfax Avenue through a 4,000-ft, 15-inch force main. The pump would require a head of about 30 feet and a power of 11 kW. The pond is sized to work in conjunction with the pump to contain excess runoff to the Penn Avenue low point. (The final design might be considered sizing the pond to contain the entire 6.9 ac-ft runoff from the 14.5-acre Penn Avenue drainage area without operation of the pump.)
- **Wentworth Avenue.** The Wentworth pond works in parallel with the main trunk sewer ("offline") so that excess flows are diverted to the two pond areas, one on each side of the trunk sewer. Inflows to the low point are introduced to the system upstream of the pond diversion structure. An orifice in the trunk line restricts discharge in the downstream pipe and forces excess flow over weirs into the ponds. The ponds discharge through small diameter outlet pipes back to the trunk line, downstream of the orifice. A sump sediment trap would be constructed between the diversion weirs and the underground storage cells to prevent sediment from entering the storage cells where it would be difficult to remove.
- **Portland Avenue.** The Portland Avenue pond accepts inflows from the upstream trunk sewer and the Portland Avenue low point. It works in parallel with the trunk line and is designed with the same conceptual layout as for Wentworth Pond.
- **TH 77.** The TH 77 pond accepts inflows from the upstream trunk sewer and from 12th Avenue and TH 77 low points. It works in parallel with the trunk line and is designed with the same conceptual layout as for Wentworth Pond.

Table D-1 Option 2E Existing Sewer with Buried Ponding under Highway

Pond Name/Location	**Penn Pond (Pumped)**	**Wentworth Pond**	**Portland Pond**	**TH 77 Pond**
Pond Dynamics	In-Series with Trunk Line	In-Series with Trunk Line	Flow not from Trunk Line	Flow not from Trunk Line
Contributing Watersheds	Penn	Colfax, Garfield, Pleasant, and Nicollet	Portland	12th Ave. and TH77
Peak 50-year Discharge Upstream of Pond				
Trunk Sewer (cfs)	85	330	94	195
Intervening Drainage to Low Point (cfs)	0	181	228	206
Pipe Invert Elevation at Pond Diversion Structure (ft)	811.8	811.5	805.1	799.0
Groundwater elevation (ft)	811.2	811.1	809.8	804.2
Mainline Orifice Downstream of Diversion				
Diameter (ft)	N/A	3.5	3.0	3.0
50-yr. peak discharge (cfs)	N/A	79	63	72
Pond Size (Total Area and Volumes)				
Pond Area (ac)	0.8	2 x 1.1 = 2.2	2 x 4.2 = 8.4	2 x 6.5 = 13
Pond Bottom Elevation (ft)	811.2	811.1	809.8	804.2
Peak Elevation (ft)	814.8	817.3	811.1	805.9
Bounce (ft)	3.6	6.2	1.3	1.7
Storage (ac-ft)	2.9	13.6	10.9	22.1
Total 50-year Storage for all Ponds (ac-ft)				49.5
Pond Inlet Weirs (two at each low point)				
Crest Length (ft)	N/A	2x18 = 36	2x30 = 60	2x40 = 80
Crest Elevation (ft)	N/A	814.5	809.8	804.2
50-year peak inflow (cfs)	N/A	2x217 = 434	2x120 = 240	2x158 = 316
Pond Outlet Pipes (two per pond)				
Diameter (RCP)	15”	12"	12"	12"
Length (ft)	4,000	50	50	50
50-year peak discharge (cfs)	3.5(pumped)	2x7.7 = 15	2x7.7 = 15	2x8.8 = 18
Mainline Pipe Downstream of Pond Outlets				
50-year peak discharge including pond discharge (cfs)	N/A	94	95	90
Pipe capacity (cfs)	N/A	169	177	263

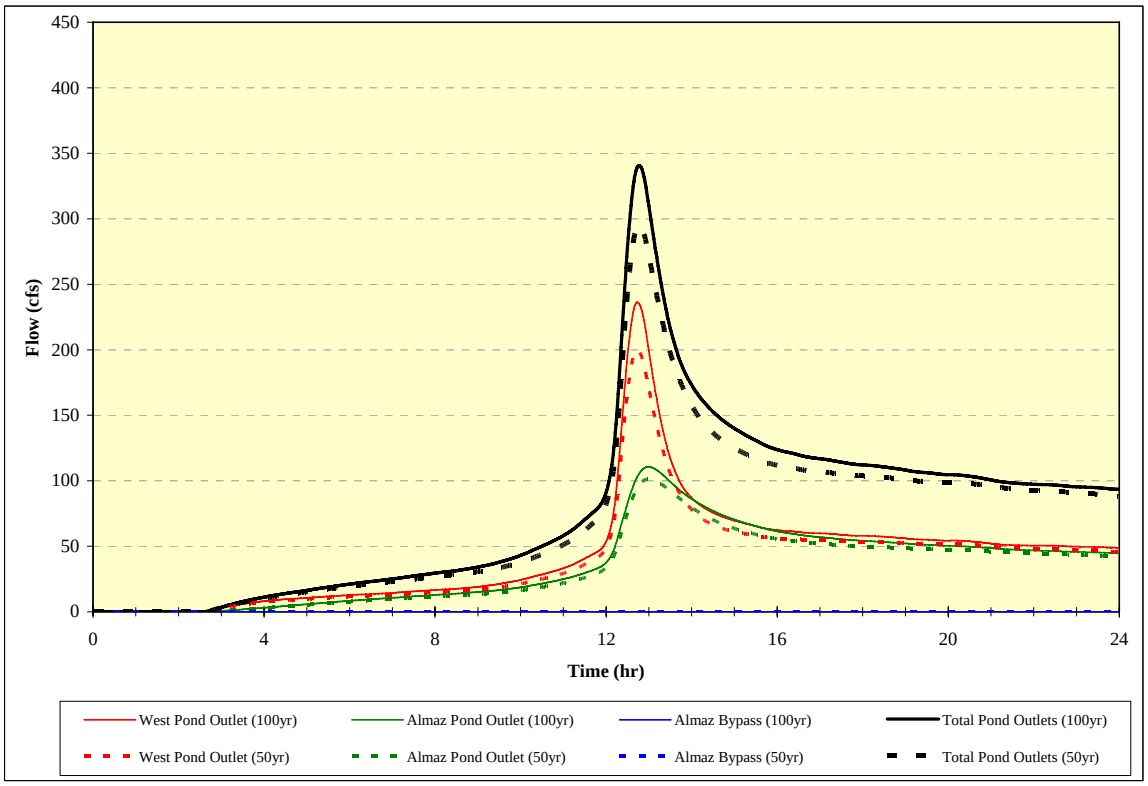
The pond storage cells are located next to and under the highway near low points and are constructed of multiple 10 feet high by 14 feet wide pre-cast concrete box sections.

Alternative 2E meets the rate control requirements for the total system discharge rate (note that the total system peak flow rate is smaller than the sums of the individual locations due to the different times to peak; see Figure D-1):

Table D-2 Alternative 2E Peak Flow Rates (cfs)

Location	Rainfall Frequency	
	50-yr, 24-hr	**100-yr, 24-hr**
Total System	295	346
Almaz Outlet	101	111
Almaz Bypass	0	0
West Pond	200	236

The Alternative 2E discharge to the Minnesota River is shown in the combined hydrograph in Figure D-1 below.



Individual Outfall, and Combined Hydrographs for Alternative 2E Discharge to the Minnesota River

Figure D-1

Water Quality

Alternative 2E is like Alternative 2D in that the buried ponding of Alternative 2E is less effective in phosphorus removal since there is no sunlight to allow growth and settling of algae, an important phosphorus sink in water quality ponds. Therefore, the ponds of Alternative 2E do not include dead storage volume.

The water quality detention volume of 52 ac-ft is substantially greater than the 19 ac-ft volume of Almaz pond so it is necessary to divert some of the discharge to Almaz pond. The flow would be split between Almaz pond and West Pond at a drop structure upstream of Almaz Pond. The diversion pipe would be 1,600 feet long and flow under the I-494 – TH 5 interchange over to the West Pond. The diversion would result in 30 ac-ft of the water quality detention volume being directed to West Pond and 22 ac-ft to Almaz pond. Since Almaz pond is somewhat overloaded, the dead storage volume of West Pond is increased to 33 ac-ft to achieve 50 percent removal; the area is 6.3 acres. See Appendix D for details of the analysis.

The West Pond outlet to the Minnesota River was modeled as a 100-ft weir which resulted in a 0.9-ft bounce during the 100-year event. The weir was enlarged to minimize unintentional storage since the soils on the site are not adequate for the construction of berms. Detail design would address the exact outlet configuration with consideration for the effects of the discharge velocity on navigation and channel stability on the Minnesota River. See Appendix C for concerns raised about the outfall by the Lower Minnesota River Watershed District.

Sediment

Sediment from the I-494 drainage system would collect in the ponds, roughly in proportion to the flow volume entering each one. The total suspended sediment load for the I-494 drainage system is estimated as 400,000 lb/yr; this represents a total volume of roughly 5,000 ft^3/yr, or 2.3 ac-ft over a twenty–year period. (This is based on a typical total suspended solids concentration of 300 mg/L, and equivalent to about 900 lb/acre.) The sediment accumulation in Alamaz and West ponds would reach about 0.9 and 1.2 acre-feet, respectively after 20 years of operation; these volumes correspond to average sediment depths of 0.3 feet and 0.2 feet, respectively.

Approximately 0.2 ac-ft would accumulate in the Penn, Wentworth, Portland, and TH77 ponds over the same 20-year period. The relatively small portion is due to the configuration of the pond diversion/inlet designs. Storms less than about 0.7 inches would not activate the pond storage, and even for larger events only a portion of the total discharge volume would enter the ponds. Due to the distribution of storm event depths, about 10 to 15 percent of the inflow at Wentworth, Portland and TH 77 ponds enters the ponds. A sump sediment trap would be constructed between the each of the diversion weirs and the underground storage cells to prevent sediment from entering the storage cells where it would be difficult to remove. The volume of each is estimated as the weir length times the width of three concrete box sections and a five-foot sump depth. Sump volumes sized this way will be sufficient to store sediment for more than twenty years.

Maintenance

As per the sedimentation discussion in Section 3, even though Mn/DOT does not use sand for snow and ice control along this section of highway, the accumulation of sediment still occurs. This material finds its way to the site on the tires of vehicles entering from sandy areas, as wind blown debris from off site, or from open topped loads of sand and aggregate that traverse the highway.

Regardless of the drainage Alternative selected, the total amount of sediment generated over the 438 acre site will remain constant. This is estimated at 4,468 cubic feet of material each year. Although a consistent street sweeping program can capture half of this material, our estimates assume that all suspended solids are conveyed to the storm sewer system.

For Alternatives 2E, which reuses the existing storm sewer system, catch basins at each storm sewer intake location will capture a large portion of the suspended solids. Further downstream, the control structures associated with each of the four ponds will be designed such that the majority of low flows will bypass the ponds altogether, carrying suspended solids to Almaz Pond. Under larger events, each detention basin in the system will be expected to capture a portion of the remaining annual sediment load (see Sediment section above).

Our assumption is that Almaz Pond, and the four ponds at Penn, Wentworth, Portland, and TH 77, will be cleaned of accumulated sediment every ten years. As with other existing detention basins, cleaning of Almaz Pond will occur during the winter, when water levels are low and access by tracked excavators and dump trucks can be made over frozen ground.

We have further assumed that 20% of the individual catch basins will be cleaned each year. Both the catch basins and the buried storage facilities will be cleaned of accumulated sediment through the use of purpose built vacuum trucks, accompanied by necessary and required support vehicles and traffic control.

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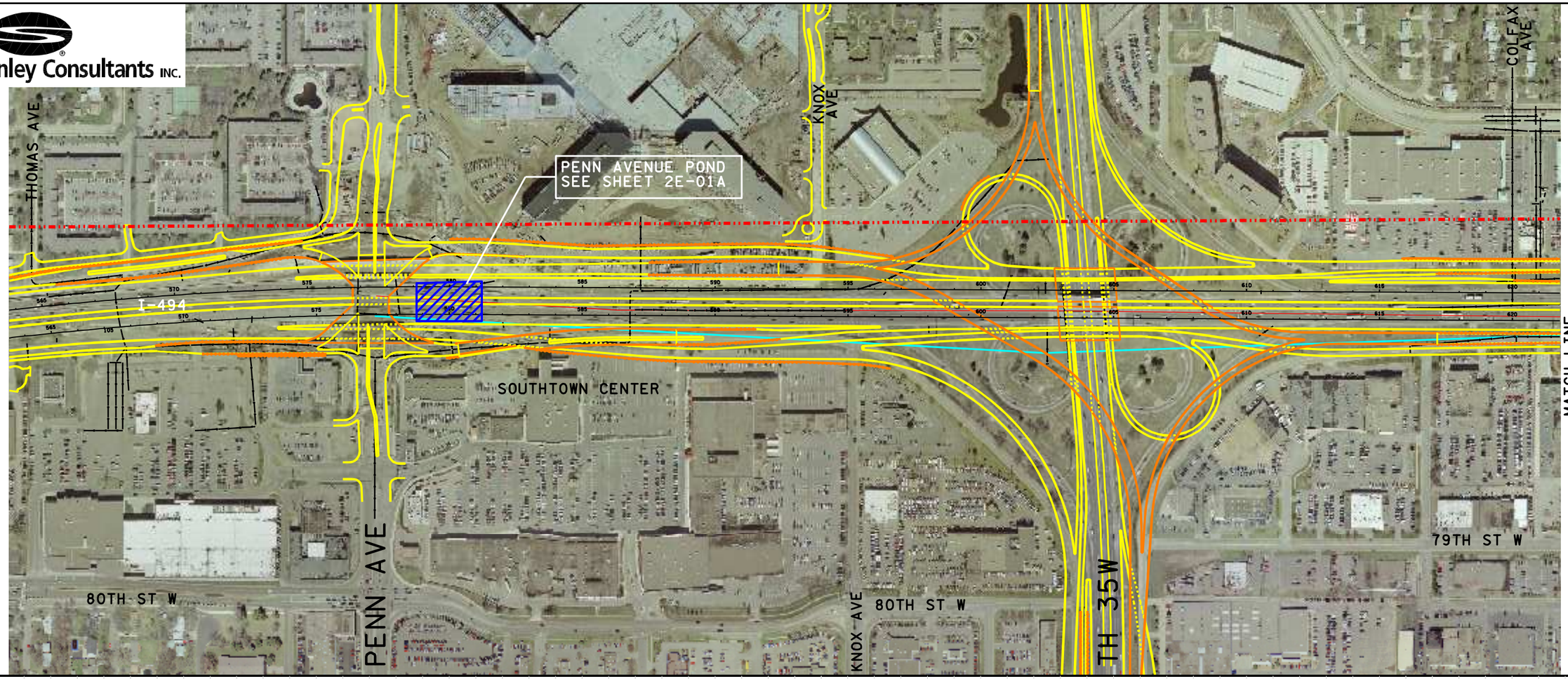

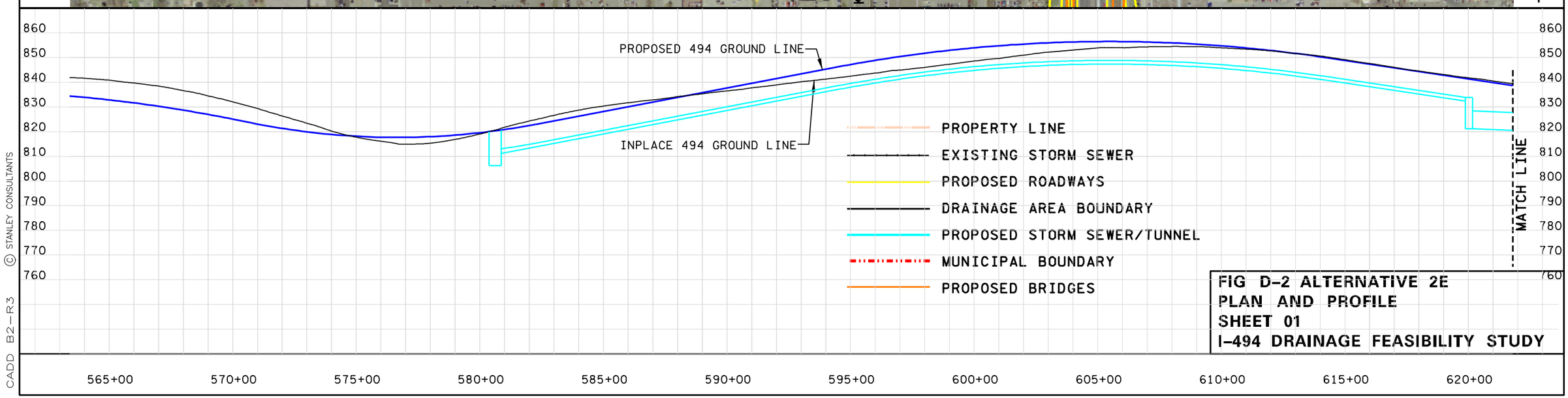

FIG D-2 ALTERNATIVE 2E
PLAN AND PROFILE
SHEET 01
I-494 DRAINAGE FEASIBILITY STUDY

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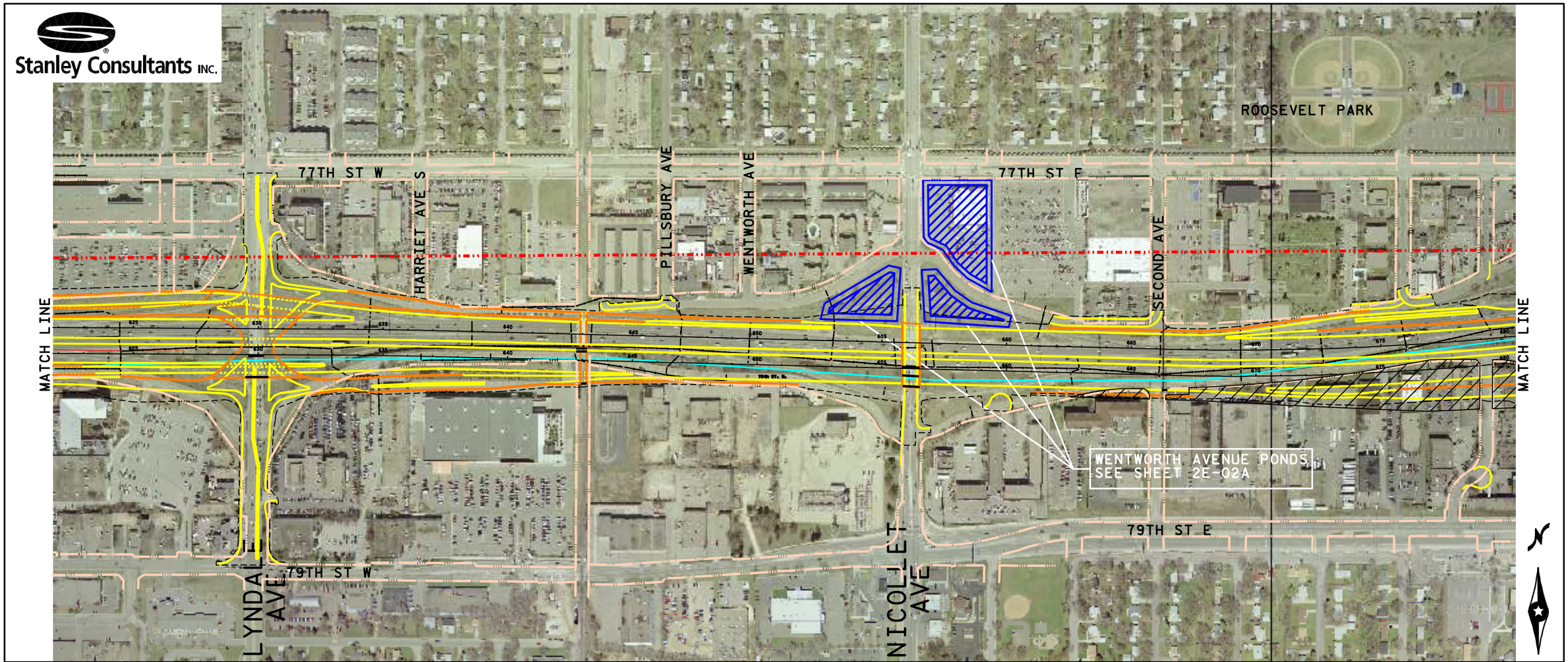

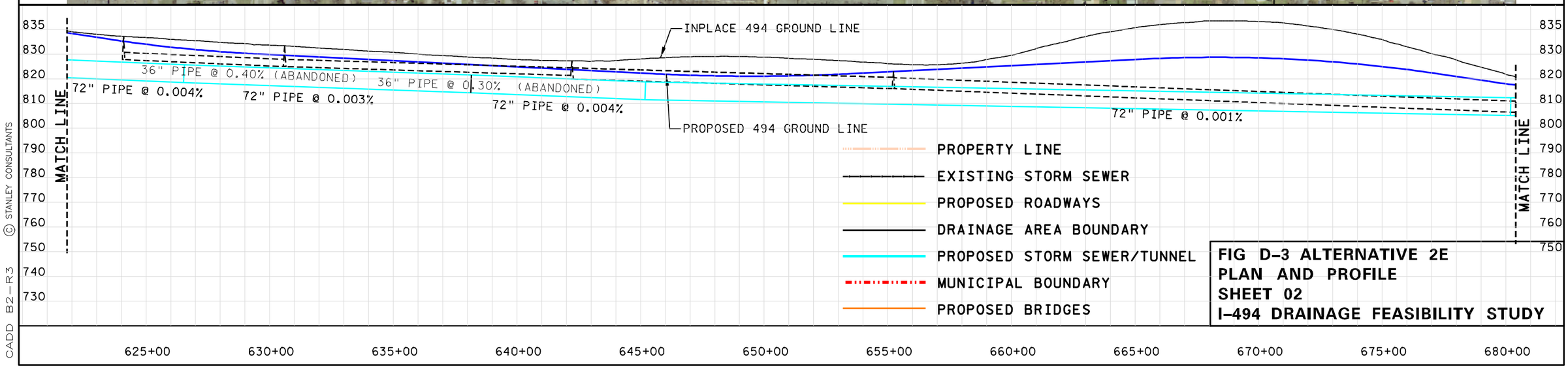

FIG D-3 ALTERNATIVE 2E
PLAN AND PROFILE
SHEET 02
I-494 DRAINAGE FEASIBILITY STUDY

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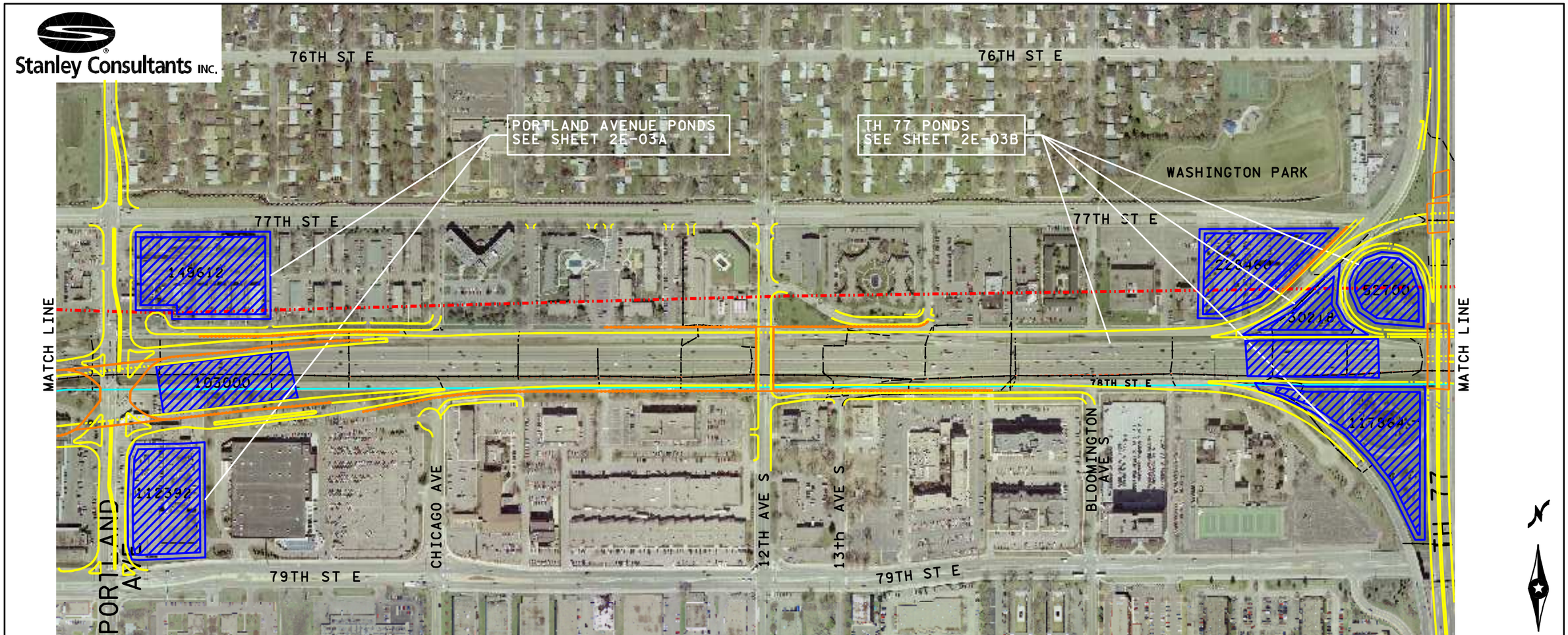

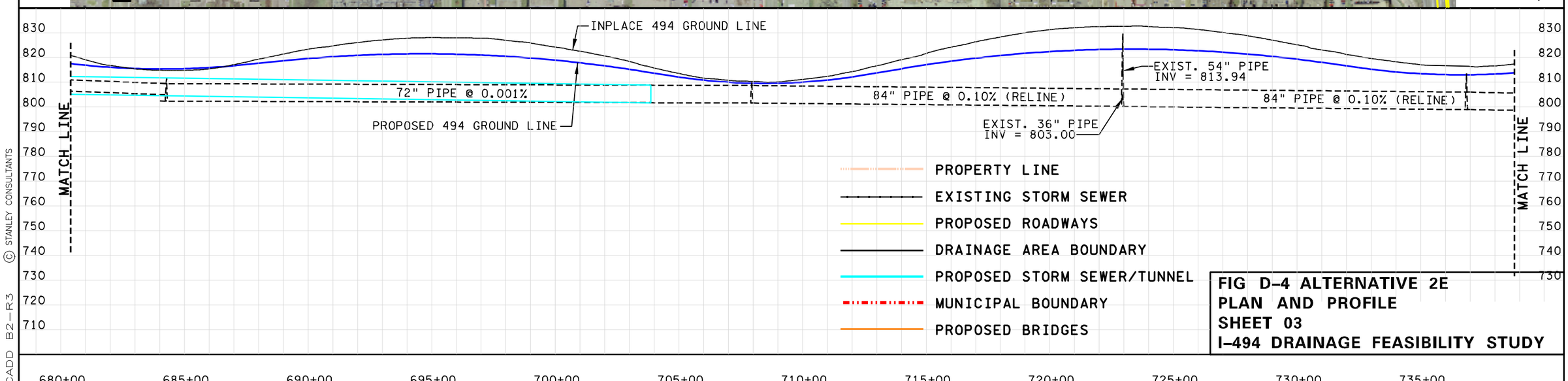

FIG D-4 ALTERNATIVE 2E
PLAN AND PROFILE
SHEET 03
I-494 DRAINAGE FEASIBILITY STUDY

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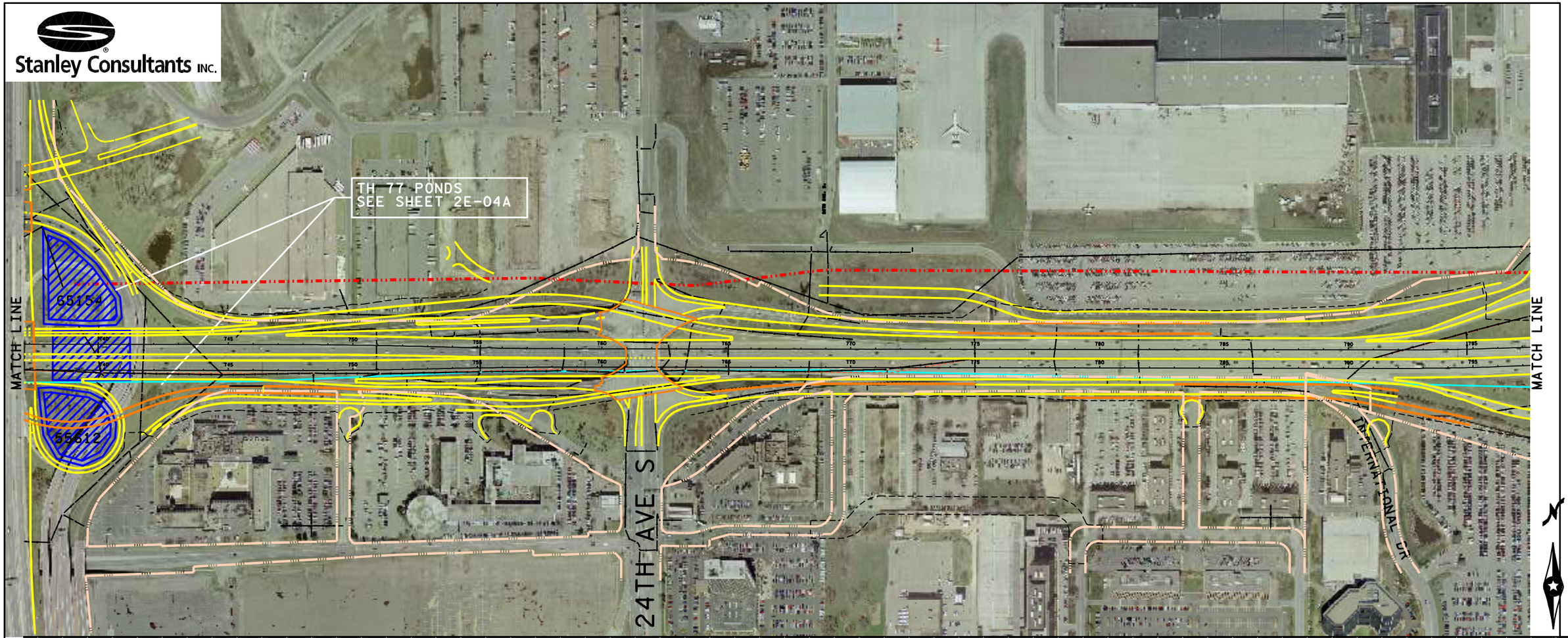

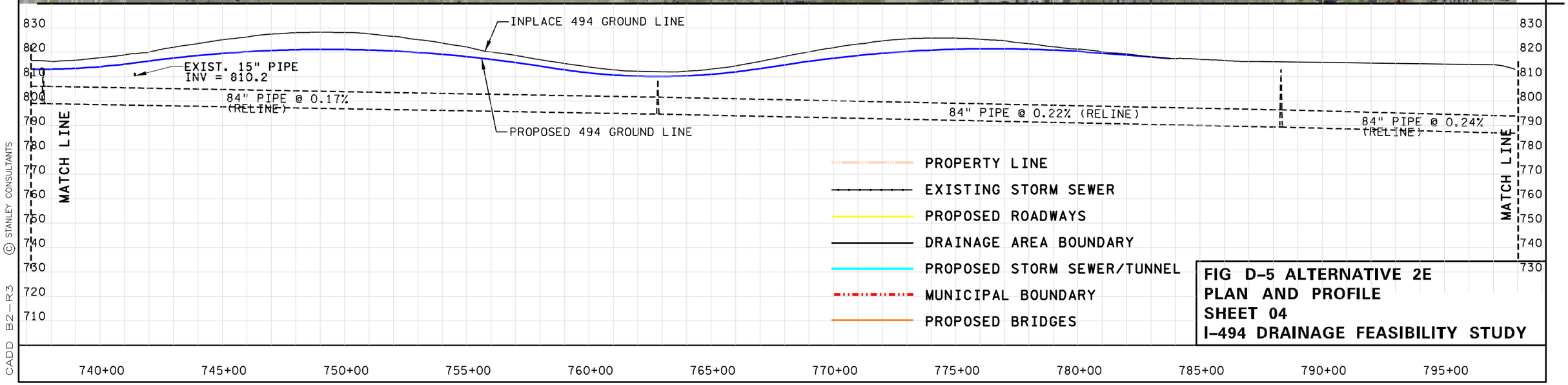

FIG D-5 ALTERNATIVE 2E
PLAN AND PROFILE
SHEET 04
I-494 DRAINAGE FEASIBILITY STUDY

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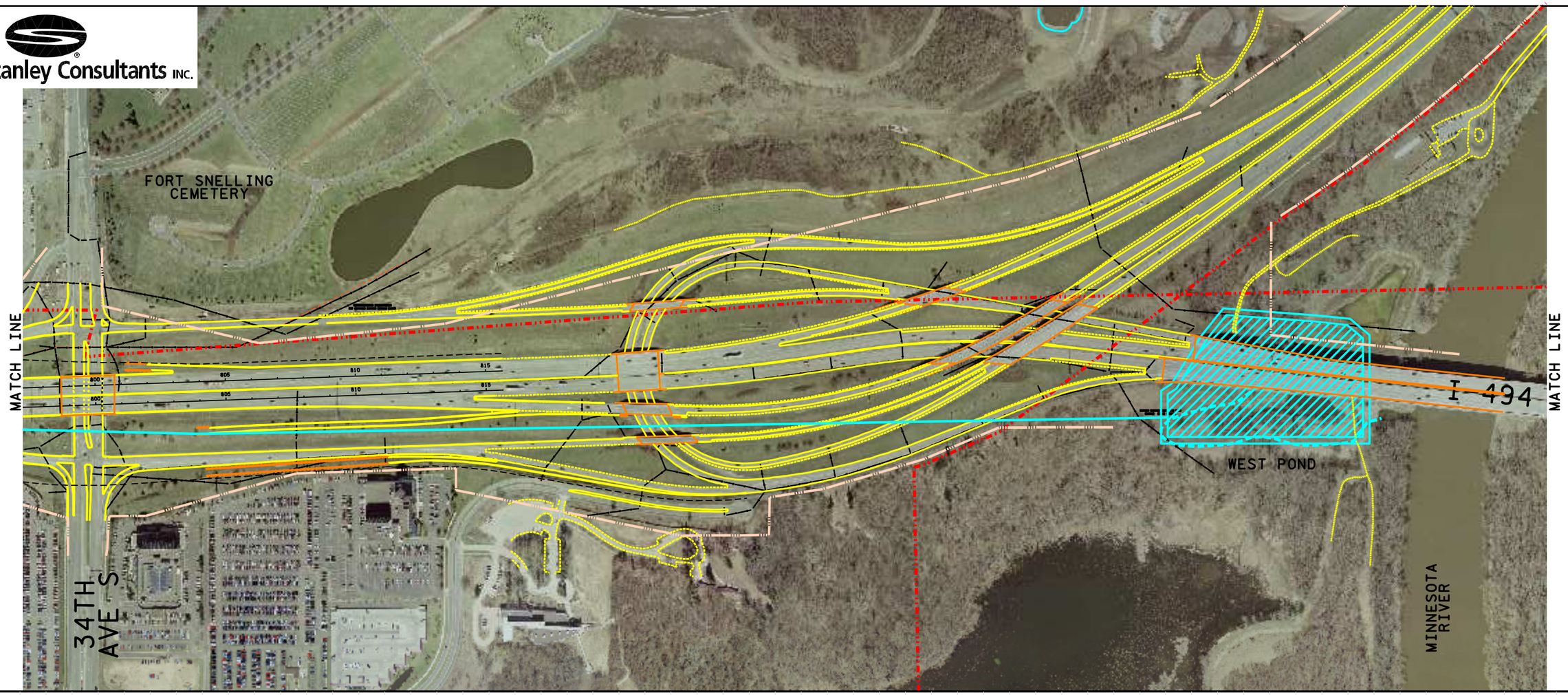

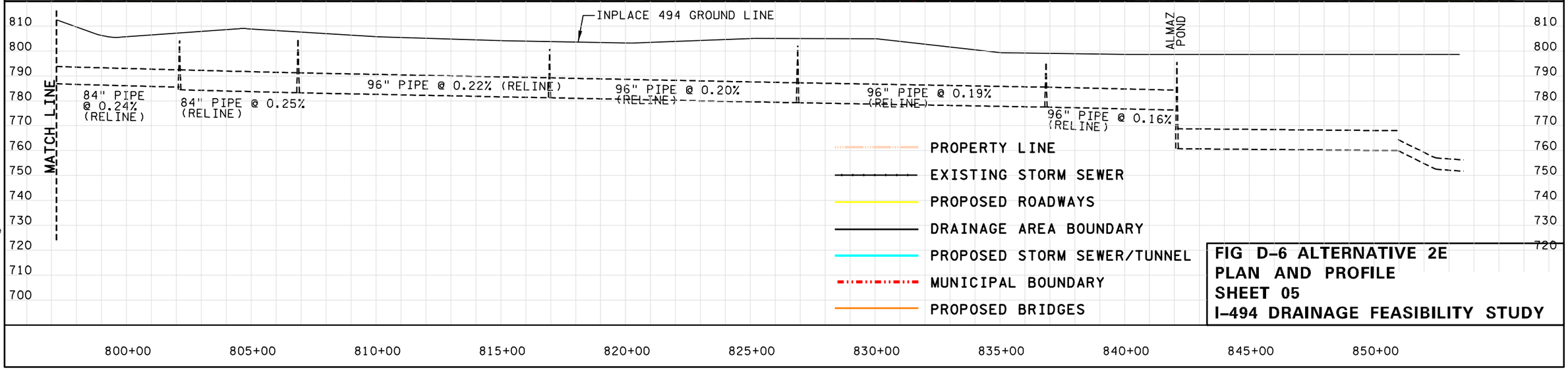

FIG D-6 ALTERNATIVE 2E
PLAN AND PROFILE
SHEET 05
I-494 DRAINAGE FEASIBILITY STUDY

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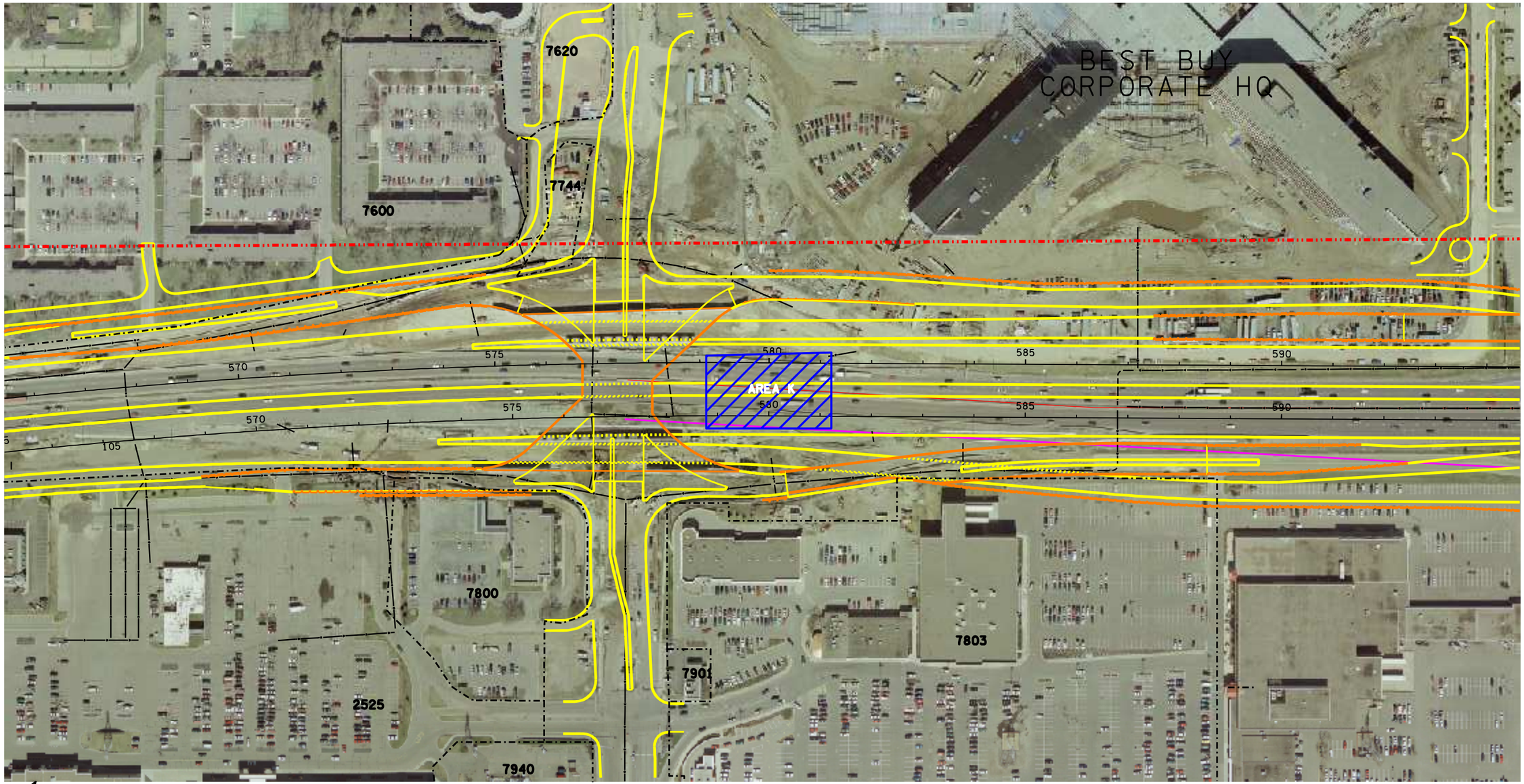

AREA K
LIVE STORAGE: 2.9 AC–FT
DEAD STORAGE: 0.0 AC–FT

SCALE: 1" = 200'

FIG D–7 ALTERNATIVE 2E–01A
ENLARGED PLAN
I–494 DRAINAGE FEASIBILITY STUDY

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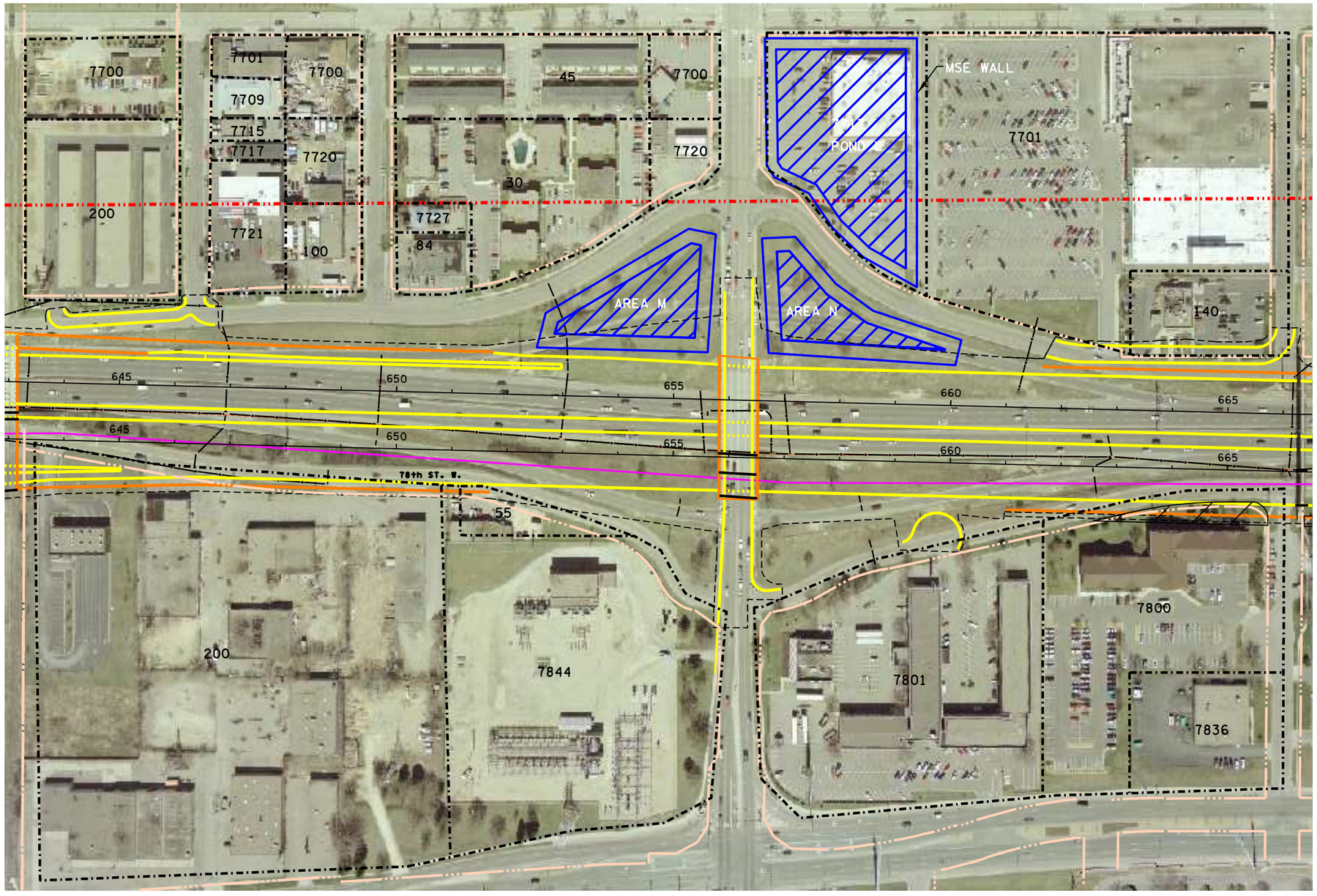

AREA L
LIVE STORAGE: 8.3 AC–FT
DEAD STORAGE: 6.8 AC–FT

PROPERTY INFO
OWNER: HIK CHI LO & YAU MUI LO
ADDRESS: 7717 NICOLLET AVE A RCHF
SIZE: 2.44 ACRE +/–

AREA M
LIVE STORAGE: 2.8 AC–FT
DEAD STORAGE: 2.3 AC–FT

AREA N
LIVE STORAGE: 2.8 AC–FT
DEAD STORAGE: 2.3 AC–FT

SCALE: 1" = 200'

FIG D–8 ALTERNATIVE 2E–02A
ENLARGED PLAN
I–494 DRAINAGE FEASIBILITY STUDY

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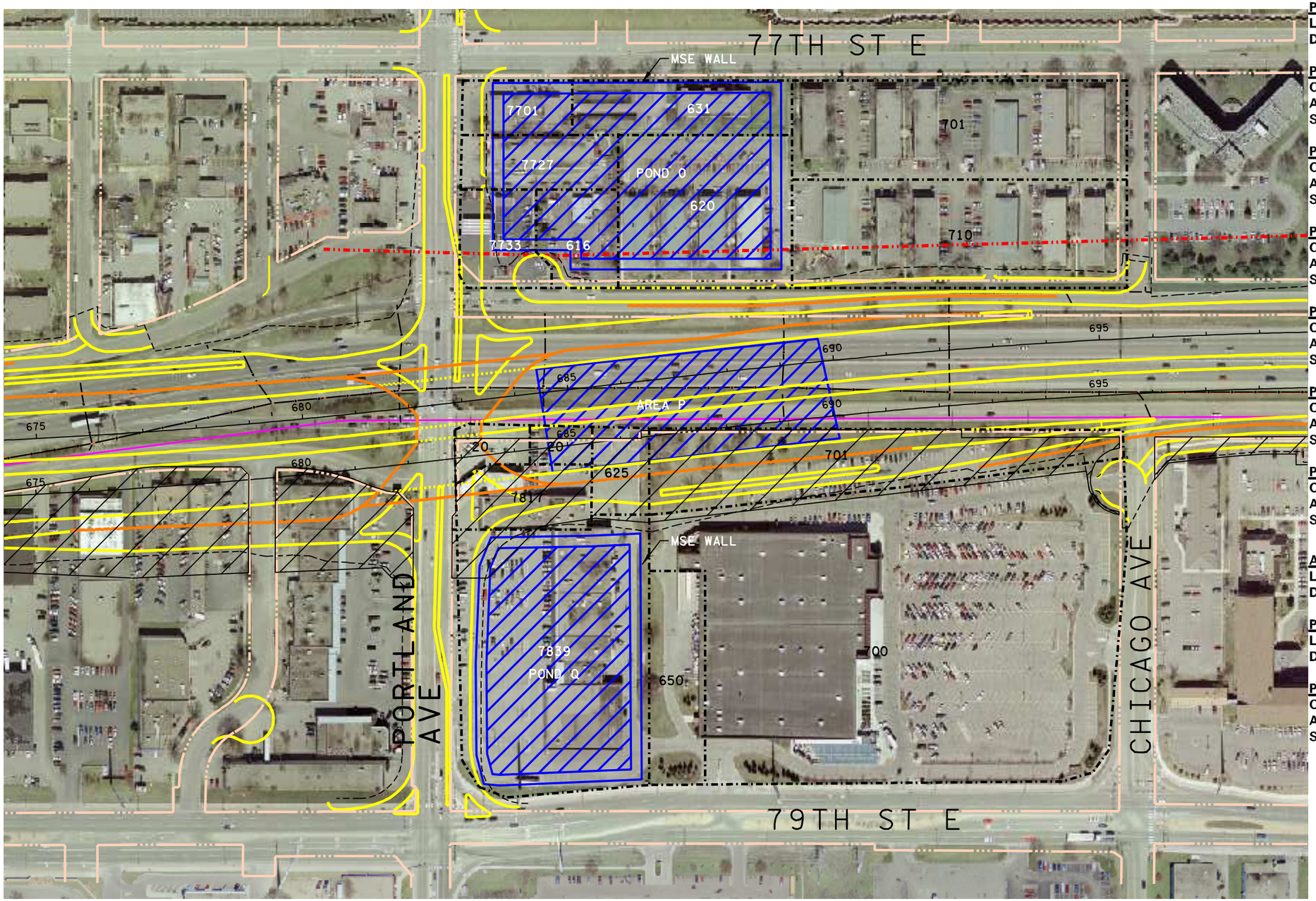

POND O
LIVE STORAGE:
DEAD STORAGE: 149,612

PROPERTY INFO
OWNER: ASIAN DRCT ORIENTAL MKT INC
ADDRESS: 7701 PORTLAND AVE RCHF
SIZE: 0.50 ACRE

PROPERTY INFO
OWNER: CAROLE L BOYUM
ADDRESS: 631 77TH ST E RCHF
SIZE: 0.94 ACRE

PROPERTY INFO
OWNER: HOMES RE 1 LLC
ADDRESS: 7727 PORTLAND AVE S RCHF
SIZE: 0.66 ACRE

PROPERTY INFO
OWNER: SINCLAIR MARKETING
ADDRESS: 7733 PORTLAND AVE S RCHF
SIZE: 0.63 ACRE +/–

PROPERTY INFO
OWNER: LOIS BERG ET AL
ADDRESS: 616 78TH ST E RCHF
SIZE: 0.60 ACRE +/–

PROPERTY INFO
OWNER: RICHFIELD APTS CENTER LLC
ADDRESS: 620 78TH ST E RCHF
SIZE: 2.08 ACRE

AREA P
LIVE STORAGE:
DEAD STORAGE: 103,000

POND Q
LIVE STORAGE:
DEAD STORAGE: 112,392

PROPERTY INFO
OWNER: VSA LLC
ADDRESS: 7839 PORTLAND AVE S RCHF
SIZE: 4.02 ACRE +/–

SCALE: 1" = 200'

FIG D–9 ALTERNATIVE 2E–03A
ENLARGED PLAN
I–494 DRAINAGE FEASIBILITY STUDY

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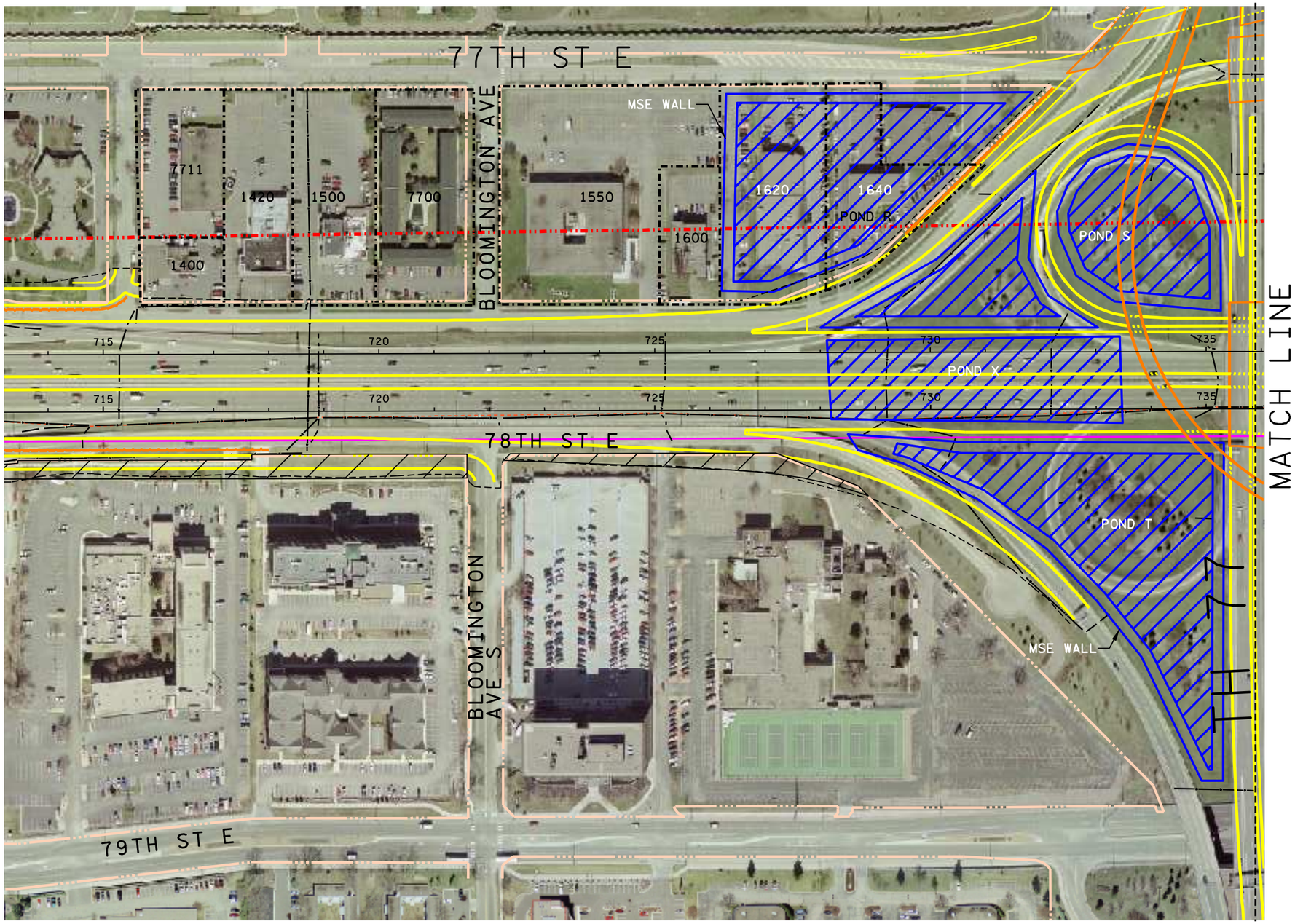

POND R
LIVE STORAGE: 3.9 AC-FT
DEAD STORAGE: 3.9 AC-FT

PROPERTY INFO
OWNER: JERRY E MATHWIG
ADDRESS: 1620 78TH ST E RCHF
SIZE: 1.74 ACRE +/-

PROPERTY INFO
OWNER: JERRY E MATHWIG
ADDRESS: 1640 78TH ST E RCHF
SIZE: 2.01 ACRE +/-

POND S
LIVE STORAGE: 3.2 AC-FT
DEAD STORAGE: 3.2 AC-FT

POND T
LIVE STORAGE: 4.6 AC-FT
DEAD STORAGE: 4.6 AC-FT

POND X
LIVE STORAGE: 3.1 AC-FT
DEAD STORAGE: 0.0 AC-FT

SCALE: 1" = 200'

FIG D-10 ALTERNATIVE 2E-03B
ENLARGED PLAN
I-494 DRAINAGE FEASIBILITY STUDY

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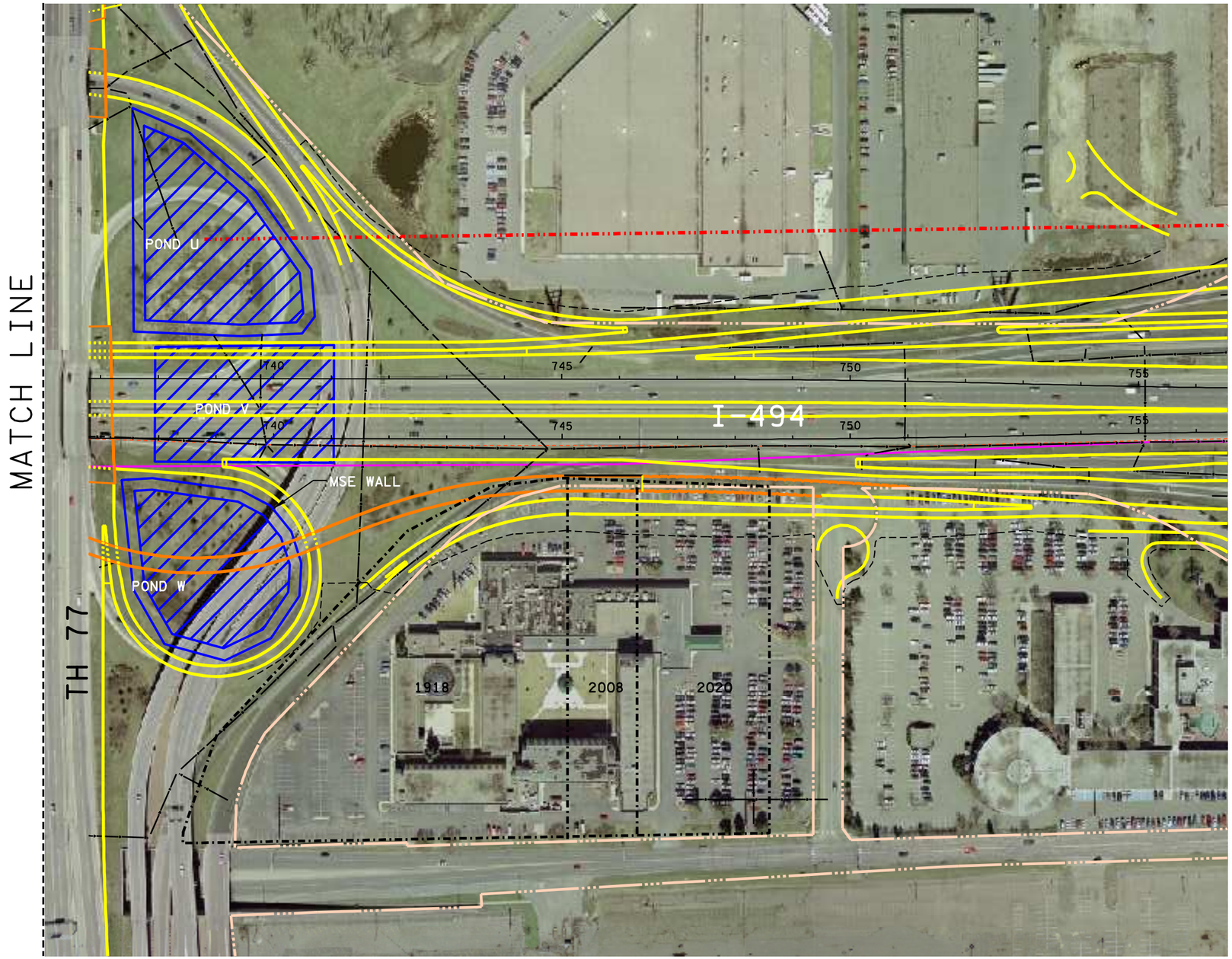


POND U
LIVE STORAGE: 2.6 AC-FT
DEAD STORAGE: 2.6 C-FT

POND V
LIVE STORAGE: 2.4 AC-FT
DEAD STORAGE: 0.0 AC-FT

POND W
LIVE STORAGE: 2.2 AC-FT
DEAD STORAGE: 2.2 AC-FT

N

SCALE: 1" = 200'

FIG D-11 ALTERNATIVE 2E-04A
ENLARGED PLAN
I-494 DRAINAGE FEASIBILITY STUDY

CADD B2-R3 © STANLEY CONSULTANTS

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION	STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 2E	Expensive land[21]	x	x			
Existing Sewer with Buried and Adjacent Ponding	Meets water quality standards			x		x
	West pond can handle the water					x
Rehabilitate and reuse the in place storm sewer.	Decision needed soon[10]	x				
Provide detention and water quality storage in new ponds constructed adjacent to the highway and within storage cells placed beneath the highway.	Provide all needed sediment and phosphorus removal					x
	Possibly pump water to Wood Lake		x			
	Use a tunnel from Penn to Lyndale and then ponds east of Lyndale		x			
	Additional space may be available for underground storage[9]	x				
Ponding at Penn Wentworth, Portland, and TH 77	Richfield has many older sites in need of redevelopment	x				
Uses West Pond for water quality	More land needed[19]			x		
Penn Ave. Pond is pumped	Ponds 20 feet below ground					x
Uses Almaz Pond for water quality	Restricted by pipe capacity[20]					x
	Resistance from Cities[8]	x	x			
	Lower MN Watershed permit required				x	
	Existing system does not cover entire corridor					x
	Pond locations subject to change	x	x			
	Maintenance component to upstream sediment basins	x				x
	Aboveground Ponds easier to clean			x	x	x
	Economical loss[22]	x	x			
	Existing pipe deterioration					x
	Existing pipe relining					x
	Do not currently use underpavement storage					x
	Potential for additional storage at West Pond					x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION	STAKEHOLDER CONCERNS	
	This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington Richfield Nine Mile Lower MN Mn/DOT

Notes:

1. Water could still be taken down to the river and treated at those ponds.
2. Met water quality standard.
3. Based on the same information as Mn/DOT.
4. The pumps would go into the new system and would not need to be programmed on a hydrograph schedule.
5. These possibilities include: remote control vehicles, future technology, better street sweeping to prevent build up of sediment in the tunnel, and stormcepters.
6. This is already an expensive project. Even if the tunnel ends up costing more, it may be worth the extra expense to avoid having to acquire more land.
7. The City of Bloomington has a much shorter timeframe than Mn/DOT, and needs to provide funding
8. Massive political problems (Richfield's land use plan is already done).
9. This space is located in Bloomington by 24th and I-494 by the airport.
10. Because of all the current construction in these areas, the Cities need to know what land the ponds will be built on so they can to help protect this land.
11. It is needed for longer term detention downstream.
12. This assumes peak flow is allowed without detention.
13. Sediment may get into the tunnel and than it will need to be removed.
14. The tunnel is more difficult to clean out then the surface ponds.
15. Maintenance costs and techniques for buried storage of this magnitude are difficult to calculate because of the lack of existing comparable systems.
16. Not used.
17. Rate control standards are not met.
18. The ponds in Bloomington that are located below the bluff are currently not meeting capacity and need maintenance.
19. This includes land beyond the ROW.
20. This leads to flooding at the low points along the corridor.
21. Richfield would double the property cost listed on the Hennepin County Assessor's site.
22. The combination of cost and disruption to the Cities is very high.

CONCEPTUAL COST ESTIMATE WITH RETAINING WALLS
I-494 STORMWATER ALTERNATIVES STUDY

Apr-07

	TOTAL ESTIMATED COST - INITIAL CONSTRUCTION	TOTAL ESTIMATED QUANTITIES - RECONSTRUCTION	TOTAL ESTIMATED COST - RECONSTRUCTION	TOTAL ESTIMATED QUANTITIES - INITIAL CONSTRUCTION
	2E	2E	2E	2E
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				
ENGINEERING AND DESIGN	$6,137,287.20	12.00%	$1,797,569.28	12.00%
Assume a set percentage of the construction cost, less right-of-way and acquisition				
	$6,137,287.20		$1,797,569.28	
PRE-CONSTRUCTION - RIGHT-OF-WAY				
RIGHT OF WAY and EASEMENTS	$39,429,132.49	$0.00	$0.00	$39,429,132.49
RELOCATION and REESTABLISHMENT	$3,640,000.00	$0.00	$0.00	$3,640,000.00
PAVEMENT REMOVAL and DEMOLITION	$1,198,000.00	$0.00	$0.00	$1,198,000.00
	$41,467,132.49		$0.00	$41,467,132.49
CONSTRUCTION - PHYSICAL CONSTRUCTION				
RCP STORM SEWER, 36" DIAMETER (surface drainage system excluded)	$12,000.00	0	$0.00	0
RCP STORM SEWER, 48" DIAMETER (surface drainage system excluded)	$0.00	0	$0.00	0
RCP STORM SEWER, 60" DIAMETER (surface drainage system excluded)	$0.00	0	$0.00	0
RCP STORM SEWER, 72" DIAMETER (surface drainage system excluded)	$1,323,680.00	0	$0.00	0
TUNNEL, 120" DIAMETER	$0.00	0	$0.00	0
TUNNEL, 144" DIAMETER	$0.00	0	$0.00	0
TUNNEL SHAFT HOLES	$0.00	0	$0.00	0
TUNNEL DRILL HOLE/ACCESS SHAFT	$0.00	0	$0.00	0
PORTAL WORK SITE (with tunnel alternatives only)	$190,000.00	0	$0.00	0
DEWATERING	$0.00	0	$40,000.00	0
MICROTUNNEL, 42" DIAMETER	$0.00	0	$0.00	0
MICROTUNNEL ACCESS SHAFTS (every 500')	$0.00	0	$0.00	0
FORCE MAIN, 16" STEEL	$240,000.00	4000	$240,000.00	4000
CATCH BASIN (ADDITIONAL DEPTH OF DRAINAGE STRUCTURE)	$288,000.00	0	$0.00	0
RESURFACE TEMPORARY ACCESS LOCATIONS, 8"	$0.00	0	$0.00	0
REHABILITATE STORM SEWER, 27" DIAMETER	$16,225.00	901	$16,225.00	901
REHABILITATE STORM SEWER, 36" DIAMETER	$3.00	200	$8,000.00	0
REHABILITATE STORM SEWER, 48" DIAMETER	$0.00	0	$0.00	0
REHABILITATE STORM SEWER, 60" DIAMETER	$0.00	0	$0.00	0
REHABILITATE STORM SEWER, 72" DIAMETER	$0.00	0	$0.00	0
REHABILITATE STORM SEWER, 84" DIAMETER	$13,470.00	6019	$381,000.00	0
REHABILITATE STORM SEWER, 96" DIAMETER	$159,600.00	11621	$813,470.00	11621
		2485	$159,600.00	2485
POND LOCATION NUMBER 1, PENN AVENUE				
EXCAVATION	$248,000.00	0	$0.00	0
TURF ESTABLISHMENT	$0.00	0	$0.00	0
PERIMETER FENCING	$0.00	0	$0.00	0
10H X 14W CONCRETE BOX CULVERT SECTIONS	$2,730,000.00	620	$682,000.00	0
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	$0.00	0	$0.00	0
CONTROL STRUCTURE (Structural Concrete)	$77,600.00	280	$20,000.00	310
RETAINING WALL	$0.00	0	$0.00	0
POND LOCATION NUMBER 2, WENTWORTH AVENUE				
EXCAVATION	$992,000.00	0	$0.00	0
TURF ESTABLISHMENT	$2,400.00	0	$0.00	0
PERIMETER FENCING	$15,400.00	0	$0.00	0
10H X 14W CONCRETE BOX CULVERT SECTIONS	$0.00	0	$0.00	0
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	$0.00	0	$0.00	0
CONTROL STRUCTURE (Structural Concrete)	$185,000.00	140	$47,500.00	0
RETAINING WALL	$2,825,000.00	40000	$1,400,000.00	0
POND LOCATION NUMBER 3, PORTLAND AVENUE				
EXCAVATION	$2,832,000.00	0	$0.00	0
TURF ESTABLISHMENT	$4,320.00	0	$0.00	0
PERIMETER FENCING	$39,600.00	0	$0.00	0
10H X 14W CONCRETE BOX CULVERT SECTIONS	$5,096,000.00	1840	$2,024,000.00	0
HDPE LINER (To meet against groundwater infiltration)	$0.00	0	$0.00	0
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	$250,000.00	290	$72,500.00	0
CONTROL STRUCTURE (Structural Concrete)	$2,150,000.00	30000	$1,050,000.00	0
RETAINING WALL				
POND LOCATION NUMBER 4, 7th/77	$2,250,000.00	0	$0.00	0
EXCAVATION	$4,800.00	0	$0.00	0
TURF ESTABLISHMENT	$19,200.00	0	$0.00	0
PERIMETER FENCING	$11,145,000.00	2530	$2,783,000.00	0
10H X 14W CONCRETE BOX CULVERT SECTIONS	$0.00	0	$0.00	0
HDPE LINER (To meet against groundwater infiltration)	$315,000.00	350	$85,000.00	0
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	$2,267,000.00	79250	$2,033,750.00	0
CONTROL STRUCTURE (Structural Concrete)				
RETAINING WALL				
WEST POND EXPANSION (Of new pond for Alternative 4A)				
EXCAVATION	$0.00	0	$0.00	0
TURF ESTABLISHMENT	$0.00	0	$0.00	0
PERIMETER FENCING	$0.00	0	$0.00	0
CONTROL STRUCTURE (Structural Concrete)	$0.00	0	$0.00	0
RETAINING WALL	$0.00	0	$0.00	0
PUMP STATION, 3.5 CFS	$150,000.00	0	$0.00	0
	$42,650,080.00		$12,483,750.00	
SUBTOTAL	$8,524,016.00	20.00%	$2,496,954.00	20.00%
CONTINGENCY	$51,144,080.00		$14,979,744.00	
CONSTRUCTION - CONSTRUCTION MANAGEMENT				
CONSTRUCTION MANAGEMENT	$2,557,203.00	5.00%	$748,987.20	5.00%
Assume a set percentage of the construction cost, less right-of-way and acquisition				
	$2,557,203.00		$748,987.20	
POST-CONSTRUCTION - MAINTENANCE				
MAINTENANCE	$719,000.00	0	$0.00	
Present value of an annuity sum				
	$719,000.00		$0.00	
TOTAL PROJECT COST, INITIAL CONSTRUCTION	$102,024,682.66			
PRE-CONSTRUCTION - ENGINEERING AND DESIGN	$6,137,287.20			
PRE-CONSTRUCTION - RIGHT-OF-WAY	$41,467,132.49			
CONSTRUCTION - PHYSICAL CONSTRUCTION	$51,144,080.00			
CONSTRUCTION - CONSTRUCTION MANAGEMENT	$2,557,203.00			
POST-CONSTRUCTION - MAINTENANCE	$719,000.00			
TOTAL PROJECT COST, YEAR 40 RECONSTRUCTION	$30,569,192.74			
PRE-CONSTRUCTION - ENGINEERING AND DESIGN	$3,135,301.82			
PRE-CONSTRUCTION - RIGHT-OF-WAY	$0.00			
CONSTRUCTION - PHYSICAL CONSTRUCTION	$26,127,515.17			
CONSTRUCTION - CONSTRUCTION MANAGEMENT	$1,306,375.76			
POST-CONSTRUCTION - MAINTENANCE	$0.00			
	$30,569,192.74			
TOTAL PROJECT COST, 80-YEAR LIFE CYCLE, 2007 DOLLARS	$132,593,875.41			
PRE-CONSTRUCTION - ENGINEERING AND DESIGN	$9,272,589.02			
PRE-CONSTRUCTION - RIGHT-OF-WAY	$41,467,132.49			
CONSTRUCTION - PHYSICAL CONSTRUCTION	$77,271,575.17			
CONSTRUCTION - CONSTRUCTION MANAGEMENT	$3,863,578.76			
POST-CONSTRUCTION - MAINTENANCE	$719,000.00			
	$132,593,875.41			

MAINTENANCE COSTS
I-494 STORMWATER ALTERNATIVES STUDY

ALTERNATIVE	1C	2C	2D	2E	2F	4A	5A
SEDIMENT ACCUMULATION	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)
PENN		3300	3300	3300	3300		
WENTWORTH		26500	2100	2100	2100		
PORTLAND		10000	1400	1400	1400		
TH 77		29100	3800	3800	3800		
ALMAZ POND	26100	31300	89600	89600	89600	74100	26100
WEST POND	74100	0	0	0	0	26100	74100
	100200	100200	100200	100200	100200	100200	100200
20-year volume [ac-ft]	2.30	2.30	2.30	2.30	2.30	2.30	2.30

SEDIMENT COLLECTION

Use upstream catch basins to collect sediment prior to entry into mainline storm sewer *

Number of intakes, EA	175	175	175	175	175	175	525
Additional height per intake, FT	4	4	4	4	4	4	4
Assumed height of additional intakes, FT	700	700	700	700	700	700	2100
At 6' diameter, provided storage per unit, CF	113	113	113	113	113	113	113
Total Intake Storage Provided, CF	19775	19775	19775	19775	19775	19775	59325
Total Intake Storage Provided, CY	732	732	732	732	732	732	2197
Catch basin volume [ac-ft]	0.45	0.45	0.45	0.45	0.45	0.45	1.36

* Assume equivalent distribution over each ponding area

Sediment to be removed from sumps **

PENN		2475	2475	2475	2475		
WENTWORTH		19875	1575	1575	1575		
PORTLAND		7500	1050	1050	1050		
TH 77		21825	2850	2850	2850		
ALMAZ POND	19575	23475	67200	67200	67200	55575	19575
WEST POND	55575					19575	55575
20-year volume to Ponds	1.73	1.73	1.73	1.73	1.73	1.73	1.73
20-year volume to Catch Basins	0.58	0.58	0.58	0.58	0.58	0.58	0.58
20-year volume total	2.30	2.30	2.30	2.30	2.30	2.30	2.30

** Assume 25% of sediment is captured in the catch basins

Maintenance Assumptions

Catch Basins

	20%	Intakes cleaned annually
	6,262.50	Sediment Cleaned Annually from sumps
	6	Intakes per hour per crew
	5.83	Crew Hours, say 8 hours
$	2,000.00	Cost per hour per crew, including traffic control
$	2.55	per cubic foot removed
$	68.98	per cubic yard removed from Catch Basins
$	16,000.00	say $ 20,000.00 per year

Ponds and Sumps Clean 20% of sumps annually

$	137.96	Cost per yard removed from Sumps
$	68.98	Cost per yard removed from Ponds

PENN		$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34		$ -
WENTWORTH		$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58		$ -
PORTLAND		$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05		$ -
TH 77		$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57		$ -

West Pond Clean every 10 years

$ 68.98 per cubic yard removed from Ponds

ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
WEST POND (I-35W OUTLET POND)	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40

SEDIMENT LOCATION	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST
INTAKES/CATCH BASINS	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 60,000.00
PENN	$ -	$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34	$ -	$ -
WENTWORTH	$ -	$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58	$ -	$ -
PORTLAND	$ -	$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05	$ -	$ -
TH 77	$ -	$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57	$ -	$ -
ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
OUTLET POND	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40
ANNUAL TOTAL	$ 29,600.00	$ 49,403.59	$ 36,708.98	$ 36,708.98	$ 36,708.98	$ 29,600.00	$ 69,600.00
PRESENT VALUE	**$ 580,000.00**	**$ 968,000.00**	**$ 719,000.00**	**$ 719,000.00**	**$ 719,000.00**	**$ 580,000.00**	**$ 1,364,000.00**

5% Inflation Rate
80 Year Economic Lifespan

Appendix E

Alternative 2F – Use Existing Sewer with Buried Ponding under Highway – Sealed System

Outfall Location

The outfalls for Alternative 2F are Almaz Pond and the expanded West Pond; both discharge to the Minnesota River near I-494. A flow splitting structure and diversion pipe would be constructed at the drop structure near Almaz Pond to direct roughly half the discharge to West Pond, in order to satisfy water quality storage requirements.

Conveyance System and Rate Control

Under Alternative 2F, the existing drainage system is utilized from Portland Avenue all the way to Almaz Pond; pipes upstream of Portland are replaced by larger pipes for increased capacity and to allow for the reduction in cover caused by the revised roadway profile.. Four new ponds are used to "shave" peaks in discharge and limit discharge to the conveyance capacity of the downstream system. In doing so, and by eliminating surcharging and flooding, Alternative 2F will reduce the overall discharge rate to the Minnesota River and exceed rate control requirements of the LMRWD. (The existing system surcharges and floods during both the 50- and 100-year events; see Wenck 2004, Appendix H.)

Sizing ponds and diversion structures for Alternative 2D (Appendix C) was subject to constraints of high groundwater, a low road profile, and an undersized trunk sewer system. The constraints led to large underground pond areas for the Portland and TH 77 ponds. ***Alternative 2F was sized with these two pond bottom elevations set about five feet below the minimum groundwater elevations*** determined from groundwater monitoring data collected as part of this study (Wenck 2007d, Appendix H). This would require that ***either the groundwater be allowed to be drawn***

down, or that the underground storage be made watertight to keep the groundwater from infiltrating and lowering.

The ground next to the highway is relatively high so that the normal pond elevations are 20 to 30 feet below grade. The 50-year maximum water levels were confined to the soffit elevation of the adjacent trunk sewer in order to meet the no-surcharge criterion. XP-SWMM model results were used to size the necessary pond. Storm sewer diversion devices and pond outlet discharge devices were sized and then tested with the assistance of the XP-SWMM model in an iterative process.

Ponds were not feasible at 24th and 12th Avenues because the groundwater was close to, or exceeded the soffit of the trunk sewer pipe. Ponds were developed at Penn, Wentworth and Portland Avenues and at TH 77. The pond dimensions are summarized in Table E-1 and their designs are described below:

- **Penn Avenue Pond and Pump Station.** The Penn Avenue pump capacity is set as 3.5 cfs (1,600 gpm) to lift the 100-year runoff volume in 24-hours. The pump would deliver the flow to the trunk sewer at Colfax Avenue through a 4,000-ft, 15-inch force main. The pump would require a head of about 30 feet and a power of 11 kW. The pond is sized to work in conjunction with the pump to contain excess runoff to the Penn Avenue low point. (The final design might consider sizing the pond to contain the entire 6.9 ac-ft runoff from the 14.5-acre Penn Avenue drainage area without operation of the pump.)
- **Wentworth Avenue Pond.** The Wentworth pond works in parallel with the main trunk sewer ("offline") so that excess flows are diverted to the two pond areas, one on each side of the trunk sewer. Inflows to the low point are introduced to the system upstream of the pond diversion structure. An orifice in the trunk line restricts discharge in the downstream pipe and forces excess flow over weirs into the ponds. The ponds discharge through small diameter outlet pipes back to the trunk line, downstream of the orifice. A sump sediment trap would be constructed between the diversion weirs and the underground storage cells to prevent sediment from entering the storage cells where it would be difficult to remove.
- **Portland Avenue Pond.** The Portland Avenue pond accepts inflows from the upstream trunk sewer and the Portland Avenue low point. It works in parallel with the trunk line. It was set 4.7 feet below the lowest groundwater observation and must be sealed or allowed to lower the local groundwater elevation. **By allowing this change, the Portland Avenue pond in Alternative 2F is just 29 percent of that for Alternative 2D.**
- **TH 77 Pond.** The TH 77 pond accepts inflows from the upstream trunk sewer and from 12th Avenue and TH 77 low points. It works in parallel with the trunk line. It was set 5.2 feet below the lowest groundwater observation and must be sealed or allowed to lower the local groundwater elevation. **By allowing this change, the Portland Avenue pond in Alternative 2F is just 23 percent the volume of that for Alternative 2D.**

Table E-1 Option 2F Existing Sewer with Buried Ponding under Highway – Sealed System (or Lowered Groundwater)

Pond Name/Location	**Penn Pond (Pumped)**	**Wentworth Pond**	**Portland Pond**	**TH 77 Pond**
Pond Dynamics	In-Series with Trunk Line	In-Series with Trunk Line	Flow not from Trunk Line	Flow not from Trunk Line
Contributing Watersheds	Penn	Colfax, Garfield, Pleasant, and Nicollet	Portland	12th Ave. and TH77
Peak 50-year Discharge Upstream of Pond				
Trunk Sewer (cfs)	85	330	94	180
Intervening Drainage to Low Point (cfs)	0	181	228	205
Pipe Invert Elevation at Pond Diversion Structure (ft)	811.8	811.5	805.1	799.0
Groundwater elevation (ft)	811.2	811.1	809.8	804.2
Mainline Orifice Downstream of Diversion				
Diameter (ft)	N/A	3.5	3	3
50-yr. peak discharge (cfs)	N/A	79	62	71
Pond Size (Total Area and Volumes)				
Pond Area (ac)	0.8	2x1.1 = 2.2	2x1.2 = 2.4	2x1.5 = 3.0
Pond Bottom Elevation (ft)	811.2	811.1	805.1	799.0
Peak Elevation (ft)	814.8	817.3	811.0	805.8
Bounce (ft)	3.6	6.2	5.9	6.8
Storage (ac-ft)	2.9	13.6	14.2	20.4
Total 50-year Storage for all Ponds (ac-ft)				51.1
Pond Inlet Weirs (two at each low point)				
Crest Length (ft)	N/A	2x18 = 36	2x10 = 20	2x15 = 30
Crest Elevation (ft)	N/A	814.5	807.6	803
50-year peak inflow (cfs)	N/A	2x217 = 434	2x123 = 246	2x151 = 302
Pond Outlet Pipes				
Diameter (in)	15”	12"	12"	12"
Length (ft)	4,000	50	50	50
50-year peak discharge (cfs)	3.5(pumped)	2x7.7 = 15.4	2x8.0 = 16.0	2x9.8 = 19.6
Mainline Pipe Downstream of Pond Outlets				
50-year peak discharge including pond discharge (cfs)	N/A	94	83	91
Pipe capacity (cfs)	N/A	169	177	263

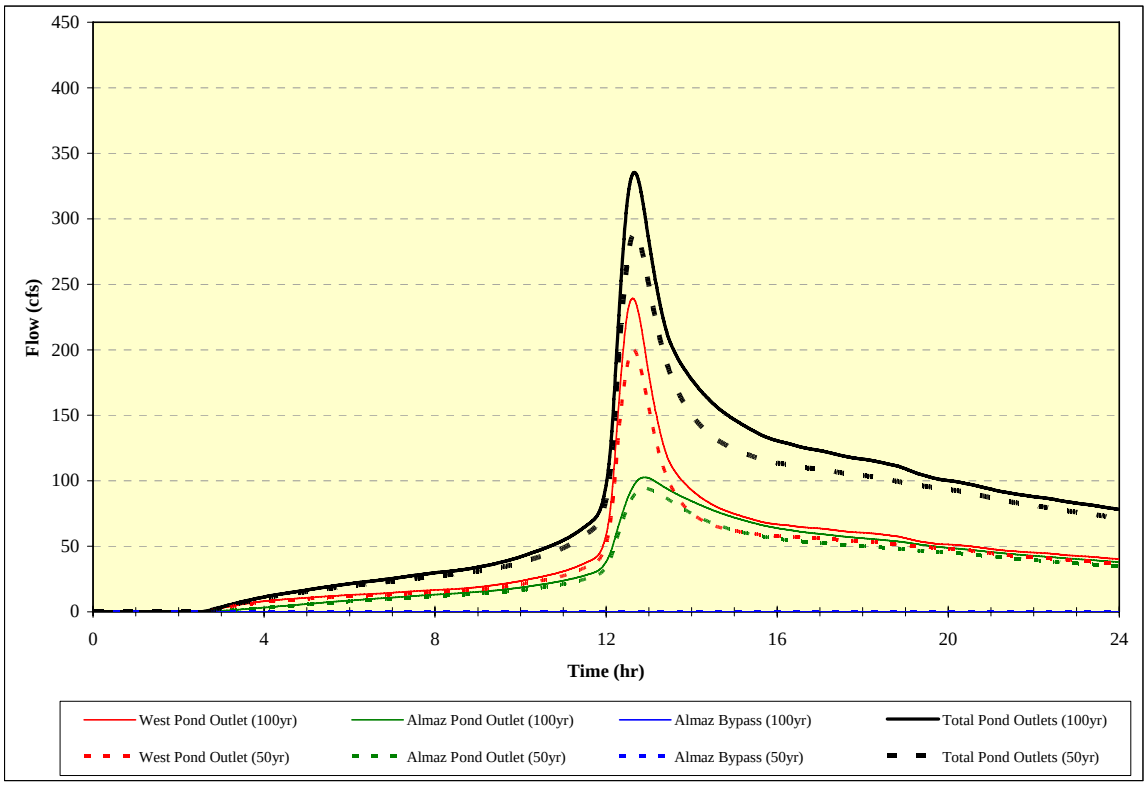
The pond storage cells are located under the highway near low points and are constructed of multiple 10 feet high by 14 feet wide pre-cast concrete box sections varying from 250 feet long at Penn to 1850 feet long at TH 77.

Alternative 2F meets the rate control requirements for the total system discharge rate (note that the total system peak flow rate is smaller than the sums of the individual locations due to the different times to peak; see Figure E-1):

Table E-2 Alternative 2F Peak Flow Rates (cfs)

Location	Rainfall Frequency	
	50-yr, 24-hr	**100-yr, 24-hr**
Total System	289	335
Almaz Outlet	94	103
Almaz Bypass	0	0
West Pond	200	239

The Alternative 2F discharge to the Minnesota River is shown in the combined hydrograph in Figure E-1 below.



Individual Outfall, and Combined Hydrographs for Alternative 2F Discharge to the Minnesota River

Figure E-1

Water Quality

Alternative 2F is the same as 2D with the exception of the Portland and TH 77 ponds which are set below the groundwater elevation and substantially smaller in area. As for Alternative 2D, buried ponding of Alternative 2F is less effective in phosphorus removal since there is no sunlight to allow growth and settling of algae, an important phosphorus sink in water quality ponds. Therefore, the ponds of Alternative 2F do not include dead storage volume.

The required water quality detention volume of 52 ac-ft is substantially greater than the 19 ac-ft volume of Almaz pond so it is necessary to divert some of the discharge to Almaz pond. The flow would be split between Almaz pond and West Pond at a drop structure upstream of Almaz Pond. The diversion pipe would be 1,600 feet long and flow under the I-494–TH 5 interchange over to the West Pond. The diversion would result in 29 ac-ft of the water quality detention volume being directed to West Pond and 23 ac-ft to Almaz pond. Since Almaz pond is somewhat overloaded, the dead storage volume of West Pond is increased to 34 ac-ft to achieve 50 percent removal. See Appendix H for details of the analysis.

The West Pond outlet to the Minnesota River was modeled as a 100-ft weir which resulted in a 0.9-ft bounce during the 100-year event. The weir was enlarged to minimize unintentional storage since additional detention storage (rate control) was not needed. Detail design would address the exact outlet configuration with consideration for the effects of the discharge velocity on navigation and channel stability on the Minnesota River. See Appendix C for concerns raised about the outfall by the Lower Minnesota River Watershed District.

Sediment

Sediment from the I-494 drainage system would collect in the ponds, roughly in proportion to the flow volume entering each one. The total suspended sediment load for the I-494 drainage system is estimated as 400,000 lb/yr; this represents a total volume of roughly 5,000 ft^3/yr, or 2.3 ac-ft over a twenty–year period. (This is based on a typical total suspended solids concentration of 300 mg/L, and equivalent to about 900 lb/acre.) The sediment accumulation in Alamaz and West ponds would reach about 0.9 and 1.2 acre-feet, respectively after 20 years of operation; these volumes correspond to average sediment depths of 0.3 feet and 0.2 feet, respectively.

Approximately 0.2 ac-ft would accumulate in the underground ponds over the same 20-year period. The relatively small portion is due to the configuration of the pond diversion / inlet designs. Storms less than about 0.7 inches would not activate the pond storage, and even for larger events only a portion of the total discharge volume would enter the underground ponds. Due to the distribution of storm event depths, about 10 to 15 percent of the inflow at Wentworth, Portland, and TH 77 ponds enters the ponds. A sump sediment trap would be constructed between the each of the diversion weirs and the underground storage cells to prevent sediment from entering the storage cells where it would be difficult to remove. The volume of each is estimated as the weir length times the width of three concrete box sections and a five-foot sump depth. Sump volumes sized this way will be sufficient to store sediment for more than twenty years.

Maintenance

As per the sedimentation discussion in Section 3, even though Mn/DOT does not use sand for snow and ice control along this section of highway, the accumulation of sediment still occurs. This material finds its way to the site on the tires of vehicles entering from sandy areas, as wind blown debris from off site, or from open topped loads of sand and aggregate that traverse the highway.

Regardless of the drainage Alternative selected, the total amount of sediment generated over the 438 acre site will remain constant. This is estimated at 4,468 cubic feet of material each year. Although a consistent street sweeping program can capture half of this material, our estimates assume that all suspended solids are conveyed to the storm sewer system.

For Alternatives 2F, which reuses the existing storm sewer system, catch basins at each storm sewer intake location will capture a large portion of the suspended solids. Further downstream, the control structures associated with each of the four ponds will be designed such that the majority of low flows will bypass the ponds altogether, carrying suspended solids to Almaz Pond. Under larger events, each detention basin in the system will be expected to capture a portion of the remaining annual sediment load (see Sediment section above).

Our assumption is that Almaz Pond, and the four ponds at Penn, Wentworth, Portland, and TH 77, will be cleaned of accumulated sediment every ten years. As with other existing detention basins, cleaning of Almaz Pond will occur during the winter, when water levels are low and access by tracked excavators and dump trucks can be made over frozen ground.

We have further assumed that 20% of the individual catch basins will be cleaned each year. Both the catch basins and the buried storage facilities will be cleaned of accumulated sediment through the use of purpose built vacuum trucks, accompanied by necessary and required support vehicles and traffic control.

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 2F	**Existing Sewer with Buried Storage, Sealed System**	Expensive land[21]	x	x			
		Meets water quality standards			x		x
		West pond can handle the water					x
		Decision needed soon[10]	x				
	Rehabilitate and reuse the in place storm sewer. Provide detention storage in storage cells placed beneath the highway.	Provide all needed sediment and phosphorus removal					x
		Possibly pump water to Wood Lake		x			
		Use a tunnel from Penn to Lyndale and then ponds east of Lyndale		x			
		Water can drain into Almaz (state pond)					x
	Ponding at Penn, Wentworth, Portland, and TH 77	Additional space may be available for underground storage[9]	x				
	Penn Ave stormwater will be pumped	Richfield has many older sites in need of redevelopment	x				
	Pipes upstream of Portland are replaced	More land needed[19]			x		
	Uses West Pond & Almaz Pond for water quality	Ponds 20 feet below ground					x
		Restricted by pipe capacity[20]					x
	Ponding is buried under roadway for detention storage only.	Resistance from Cities[8]	x	x			
		Lower MN Watershed permit required				x	
		Existing system does not cover entire corridor					x
		Pond locations subject to change	x	x			
		Maintenance component to upstream sediment basins	x				x
		Economical loss[22]	x	x			
		Existing pipe deterioration					x
		Existing pipe relining					x
		Do not currently use underpavement storage					x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION	STAKEHOLDER CONCERNS				
	This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT

Notes:

1. Water could still be taken down to the river and treated at those ponds.
2. Met water quality standard.
3. Based on the same information as Mn/DOT.
4. The pumps would go into the new system and would not need to be programmed on a hydrograph schedule.
5. These possibilities include: remote control vehicles, future technology, better street sweeping to prevent build up of sediment in the tunnel, and stormcepters.
6. This is already an expensive project. Even if the tunnel ends up costing more, it may be worth the extra expense to avoid having to acquire more land.
7. The City of Bloomington has a much shorter timeframe than Mn/DOT, and needs to provide funding
8. Massive political problems (Richfield's land use plan is already done).
9. This space is located in Bloomington by 24th and I-494 by the airport.
10. Because of all the current construction in these areas, the Cities need to know what land the ponds will be built on so they can to help protect this land.
11. It is needed for longer term detention downstream.
12. This assumes peak flow is allowed without detention.
13. Sediment may get into the tunnel and than it will need to be removed.
14. The tunnel is more difficult to clean out then the surface ponds.
15. Maintenance costs and techniques for buried storage of this magnitude are difficult to calculate because of the lack of existing comparable systems.
16. Not used.
17. Rate control standards are not met.
18. The ponds in Bloomington that are located below the bluff are currently not meeting capacity and need maintenance.
19. This includes land beyond the ROW.
20. This leads to flooding at the low points along the corridor.
21. Richfield would double the property cost listed on the Hennepin County Assessor's site.
22. The combination of cost and disruption to the Cities is very high.

CONCEPTUAL COST ESTIMATE WITH RETAINING WALLS
I-494 STORMWATER ALTERNATIVES STUDY

Apr-07

				TOTAL ESTIMATED QUANTITIES - INITIAL CONSTRUCTION	TOTAL ESTIMATED COST - INITIAL CONSTRUCTION	TOTAL ESTIMATED QUANTITIES - RECONSTRUCTION	TOTAL ESTIMATED COST - RECONSTRUCTION
				2F	2F	2F	2F
PRE-CONSTRUCTION - ENGINEERING AND DESIGN		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
ENGINEERING AND DESIGN			VARIES	12.00%	$5,324,450.40	12.00%	$1,383,648.48
Assume a set percentage of the construction cost, less right-of-way and acquisition							
					$5,324,450.40		**$1,383,648.48**

PRE-CONSTRUCTION - RIGHT-OF-WAY		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
RIGHT OF WAY and EASEMENTS		LUMP SUM	VARIES	$13,835.21	$13,835.21	$0.00	$0.00
RELOCATION and REESTABLISHMENT		LUMP SUM	VARIES	$0.00	$0.00	$0.00	$0.00
PAVEMENT REMOVAL and DEMOLITION		LUMP SUM	VARIES	$0.00	$0.00	$0.00	$0.00
					$13,835.21		**$0.00**

CONSTRUCTION - PHYSICAL CONSTRUCTION		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
RCP STORM SEWER, 36" DIAMETER (surface drainage system excluded)	2503.511/00363	LF	$60.00	200	$12,000.00	0	$0.00
RCP STORM SEWER, 48" DIAMETER (surface drainage system excluded)	2503.511/00483	LF	$90.00	0	$0.00	0	$0.00
RCP STORM SEWER, 60" DIAMETER (surface drainage system excluded)	2503.511/00603	LF	$150.00	0	$0.00	0	$0.00
RCP STORM SEWER, 72" DIAMETER (surface drainage system excluded)	2503.511/00723	LF	$220.00	6018	$1,323,960.00	0	$0.00
TUNNEL, 120" DIAMETER		LF	$3,000.00	0	$0.00	0	$0.00
TUNNEL, 144" DIAMETER		LF	$3,500.00	0	$0.00	0	$0.00
TUNNEL SHAFT HOLES		EACH	$285,000.00	0	$0.00	0	$0.00
TUNNEL DRILL HOLE/ACCESS SHAFT		EACH	$115,000.00	0	$0.00	0	$0.00
PORTAL WORK SITE (with tunnel alternatives only)		LUMP SUM	$115,000.00	0	$0.00	0	$0.00
DEWATERING		500' UNITS	$20,000.00	8	$160,000.00	2	$40,000.00
MICROTUNNEL, 42" DIAMETER		LF	$1,000.00	0	$0.00	0	$0.00
MICROTUNNEL ACCESS SHAFTS (every 500')		EACH	$115,000.00	0	$0.00	0	$0.00
FORCE MAIN, 18" STEEL	2504.603/02018	LF	$60.00	4000	$240,000.00	4000	$240,000.00
CATCH BASIN (ADDITIONAL DEPTH OR DRAINAGE STRUCTURE)	2506.501/03620	LF	$380.00	700	$266,000.00	0	$0.00
RESURFACE TEMPORARY ACCESS LOCATIONS, 5"	2350.501.23200	SF	$2.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 27" DIAMETER		LF	$20.00	801	$16,020.00	801	$16,020.00
REHABILITATE STORM SEWER, 36" DIAMETER		LF	$30.00	0	$0.00	200	$6,000.00
REHABILITATE STORM SEWER, 48" DIAMETER		LF	$40.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 60" DIAMETER		LF	$50.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 72" DIAMETER		LF	$60.00	0	$0.00	6018	$361,080.00
REHABILITATE STORM SEWER, 84" DIAMETER		LF	$70.00	11621	$813,470.00	11621	$813,470.00
REHABILITATE STORM SEWER, 96" DIAMETER		LF	$80.00	2485	$198,800.00	2485	$198,800.00
POND LOCATION NUMBER 1, PENN AVENUE							
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	18000	$144,000.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$6,000.00	0	$0.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	2490	$2,739,000.00	620	$682,000.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)		LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03631	CUBIC YARD	$250.00	310	$77,500.00	80	$20,000.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
POND LOCATION NUMBER 2, WENTWORTH AVENUE							
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	49000	$392,000.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$6,000.00	0	$0.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	6850	$7,535,000.00	1710	$1,881,000.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)		LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03631	CUBIC YARD	$250.00	740	$185,000.00	190	$47,500.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
POND LOCATION NUMBER 3, PORTLAND AVENUE							
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	53000	$424,000.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$6,000.00	0	$0.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	7470	$8,217,000.00	1870	$2,057,000.00
HDPE LINER (To seal against groundwater infiltration)		SQUARE FOOT	$3.00	209180	$627,480.00	52290	$156,870.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)		LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03631	CUBIC YARD	$250.00	1160	$290,000.00	290	$72,500.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
POND LOCATION NUMBER 4, TH77							
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	66000	$528,000.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$9,000.00	0	$0.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.511/12100	LINEAR FOOT	$1,100.00	9330	$10,263,000.00	2330	$2,563,000.00
HDPE LINER (To seal against groundwater infiltration)		SQUARE FOOT	$3.00	261240	$783,720.00	65310	$195,930.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)		LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03631	CUBIC YARD	$250.00	1500	$375,000.00	360	$95,000.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
WEST POND EXPANSION (Or new pond for Alternative 4A)							
EXCAVATION	2105.515/00010	CUBIC YARD	$8.00	112000	$896,000.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$6,000.00	0.55	$3,300.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$12.00	2300	$27,600.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/03631	CUBIC YARD	$250.00	92	$22,500.00	20	$5,000.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	9000	$315,000.00	4500	$157,500.00
PUMP STATION, 3.5 CFS		LUMP SUM	$100,000.00	1	$100,000.00	0	$0.00
SUBTOTAL					$36,975,360.00		$9,908,870.00
CONTINGENCY				20.00%	$7,395,070.00	20.00%	$1,621,734.00
					$44,370,420.00		**$11,530,404.00**

CONSTRUCTION - CONSTRUCTION MANAGEMENT		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
CONSTRUCTION MANAGEMENT			VARIES	5.00%	$2,218,521.00	5.00%	$576,520.20
Assume a set percentage of the construction cost, less right-of-way and acquisition							
					$2,218,521.00		**$576,520.20**

POST-CONSTRUCTION - MAINTENANCE		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
MAINTENANCE			LUMP SUM	1	$719,000.00	0	$0.00
Present value of an annual sum							
					$719,000.00		**$0.00**

TOTAL PROJECT COST, INITIAL CONSTRUCTION		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES, YEAR 40	TOTAL ESTIMATED COST, PRESENT VALUE OF YEAR 40 CONSTRUCTION
PRE-CONSTRUCTION - ENGINEERING AND DESIGN					$5,324,450.40		$2,665,149.25
PRE-CONSTRUCTION - RIGHT-OF-WAY					$13,835.21		$0.00
CONSTRUCTION - PHYSICAL CONSTRUCTION					$44,370,420.00		$22,376,243.73
CONSTRUCTION - CONSTRUCTION MANAGEMENT					$2,218,521.00		$1,118,812.19
POST-CONSTRUCTION - MAINTENANCE					$719,000.00		$0.00
					$52,646,226.61		**$26,180,205.17**

TOTAL PROJECT COST, YEAR 40 RECONSTRUCTION		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST, PRESENT VALUE OF YEAR 40 CONSTRUCTION
PRE-CONSTRUCTION - ENGINEERING AND DESIGN					$2,665,149.25
PRE-CONSTRUCTION - RIGHT-OF-WAY					$0.00
CONSTRUCTION - PHYSICAL CONSTRUCTION					$22,376,243.73
CONSTRUCTION - CONSTRUCTION MANAGEMENT					$1,118,812.19
POST-CONSTRUCTION - MAINTENANCE					$0.00
					$26,180,205.17

TOTAL PROJECT COST, 80-YEAR LIFE CYCLE, 2007 DOLLARS		UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	0
PRE-CONSTRUCTION - ENGINEERING AND DESIGN					$8,009,599.85
PRE-CONSTRUCTION - RIGHT-OF-WAY					$13,835.21
CONSTRUCTION - PHYSICAL CONSTRUCTION					$56,746,663.73
CONSTRUCTION - CONSTRUCTION MANAGEMENT					$3,337,333.19
POST-CONSTRUCTION - MAINTENANCE					$719,000.00
					$78,826,431.77

MAINTENANCE COSTS
I-494 STORMWATER ALTERNATIVES STUDY

ALTERNATIVE	1C	2C	2D	2E	2F	4A	5A
SEDIMENT ACCUMULATION	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)
PENN		3300	3300	3300	3300		
WENTWORTH		26500	2100	2100	2100		
PORTLAND		10000	1400	1400	1400		
TH 77		29100	3800	3800	3800		
ALMAZ POND	26100	31300	89600	89600	89600	74100	26100
WEST POND	74100	0	0	0	0	26100	74100
	100200	100200	100200	100200	100200	100200	100200
20-year volume [ac-ft]	2.30	2.30	2.30	2.30	2.30	2.30	2.30

SEDIMENT COLLECTION

Use upstream catch basins to collect sediment prior to entry into mainline storm sewer *

Number of Intakes, EA	175	175	175	175	175	175	525
Additional height per intake, FT	4	4	4	4	4	4	4
Assumed height of additional intakes, FT	700	700	700	700	700	700	2100
At 6' diameter, provided storage per unit, CF	113	113	113	113	113	113	113
Total Intake Storage Provided, CF	19775	19775	19775	19775	19775	19775	59325
Total Intake Storage Provided, CY	732	732	732	732	732	732	2197
Catch basin volume [ac-ft]	0.45	0.45	0.45	0.45	0.45	0.45	1.36

* Assume equivalent distribution over each ponding area

Sediment to be removed from sumps **

PENN		2475	2475	2475	2475		
WENTWORTH		19875	1575	1575	1575		
PORTLAND		7500	1050	1050	1050		
TH 77		21825	2850	2850	2850		
ALMAZ POND	19575	23475	67200	67200	67200	55575	19575
WEST POND	55575					19575	55575
20-year volume to Ponds	1.73	1.73	1.73	1.73	1.73	1.73	1.73
20-year volume to Catch Basins	0.58	0.58	0.58	0.58	0.58	0.58	0.58
20-year volume total	2.30	2.30	2.30	2.30	2.30	2.30	2.30

** Assume 25% of sediment is captured in the catch basins

Maintenance Assumptions

Catch Basins

	20%	Intakes cleaned annually
	6,262.50	Sediment Cleaned Annually from sumps
	6	Intakes per hour per crew
	5.83	Crew Hours, say 8 hours
$	2,000.00	Cost per hour per crew, including traffic control
$	2.55	per cubic foot removed
$	68.98	per cubic yard removed from Catch Basins
$	16,000.00	say $ 20,000.00 per year

Ponds and Sumps Clean 20% of sumps annually

$	137.96	Cost per yard removed from Sumps
$	68.98	Cost per yard removed from Ponds

PENN		$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34		$ -
WENTWORTH		$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58		$ -
PORTLAND		$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05		$ -
TH 77		$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57		$ -

West Pond Clean every 10 years

$	68.98	per cubic yard removed from Ponds

ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
WEST POND (I-35W OUTLET POND)	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40

SEDIMENT LOCATION	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST
INTAKES/CATCH BASINS	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 60,000.00
PENN	$ -	$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34	$ -	$ -
WENTWORTH	$ -	$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58	$ -	$ -
PORTLAND	$ -	$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05	$ -	$ -
TH 77	$ -	$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57	$ -	$ -
ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
OUTLET POND	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40
ANNUAL TOTAL	$ 29,600.00	$ 49,403.59	$ 36,708.98	$ 36,708.98	$ 36,708.98	$ 29,600.00	$ 69,600.00
PRESENT VALUE	**$ 580,000.00**	**$ 968,000.00**	**$ 719,000.00**	**$ 719,000.00**	**$ 719,000.00**	**$ 580,000.00**	**$ 1,364,000.00**

5% Inflation Rate
80 Year Economic Lifespan

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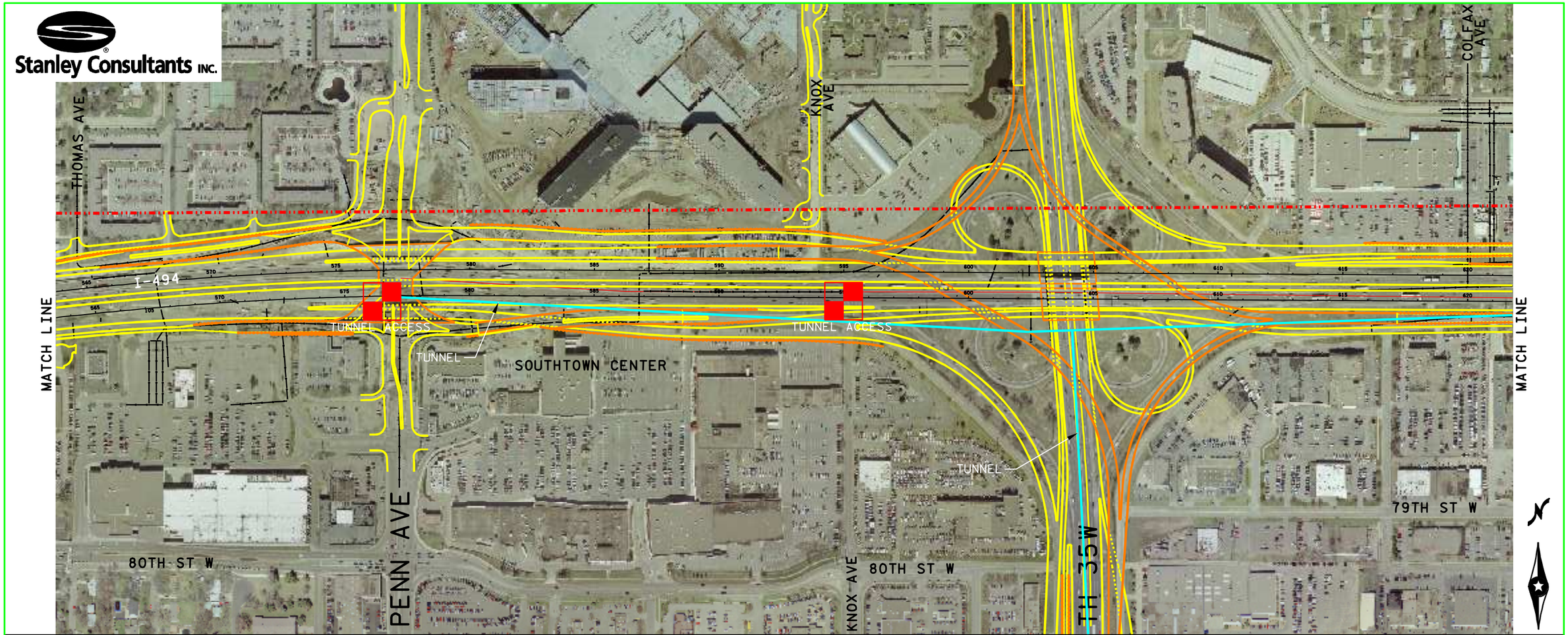

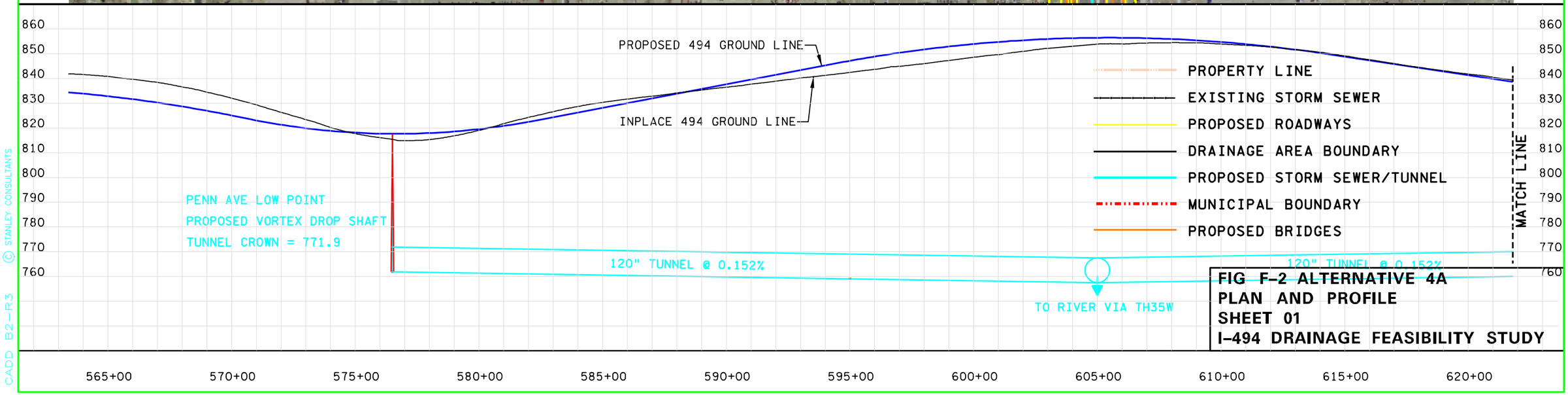

FIG F-2 ALTERNATIVE 4A
PLAN AND PROFILE
SHEET 01
I-494 DRAINAGE FEASIBILITY STUDY

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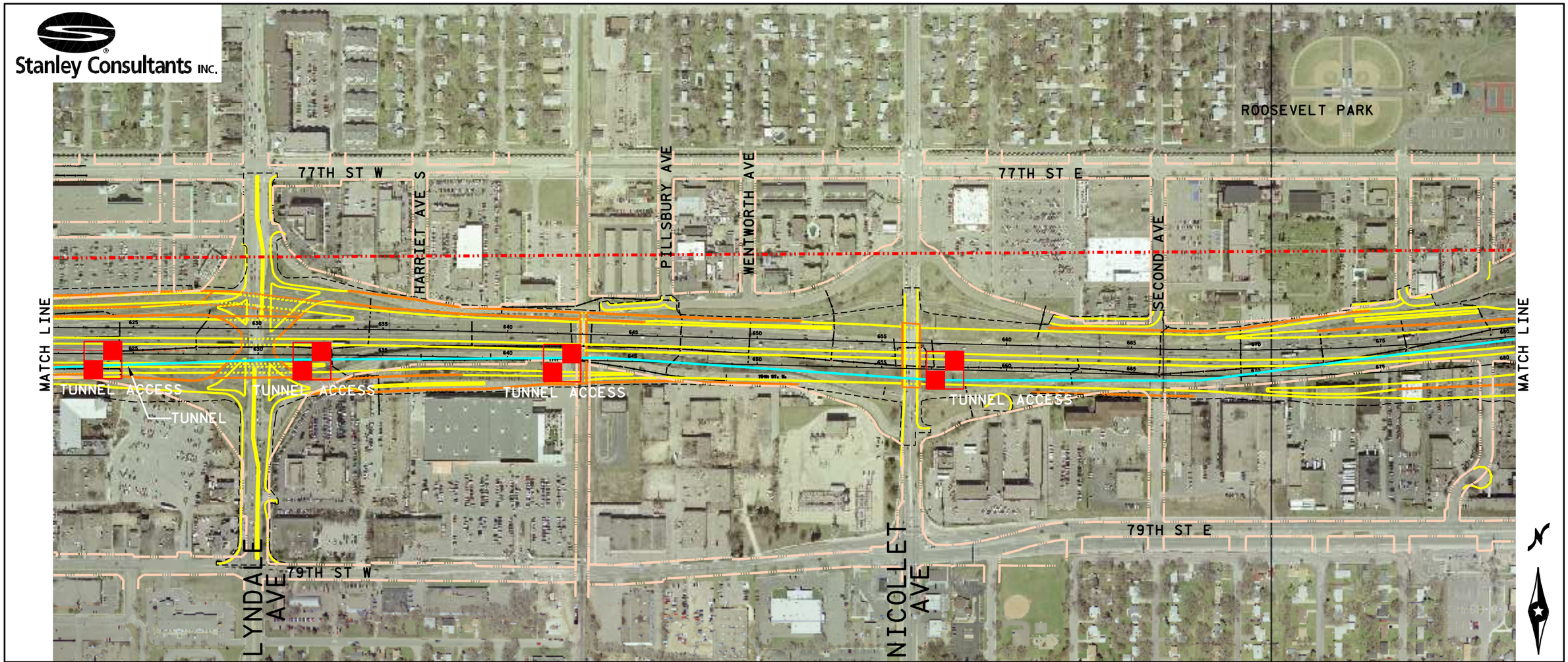

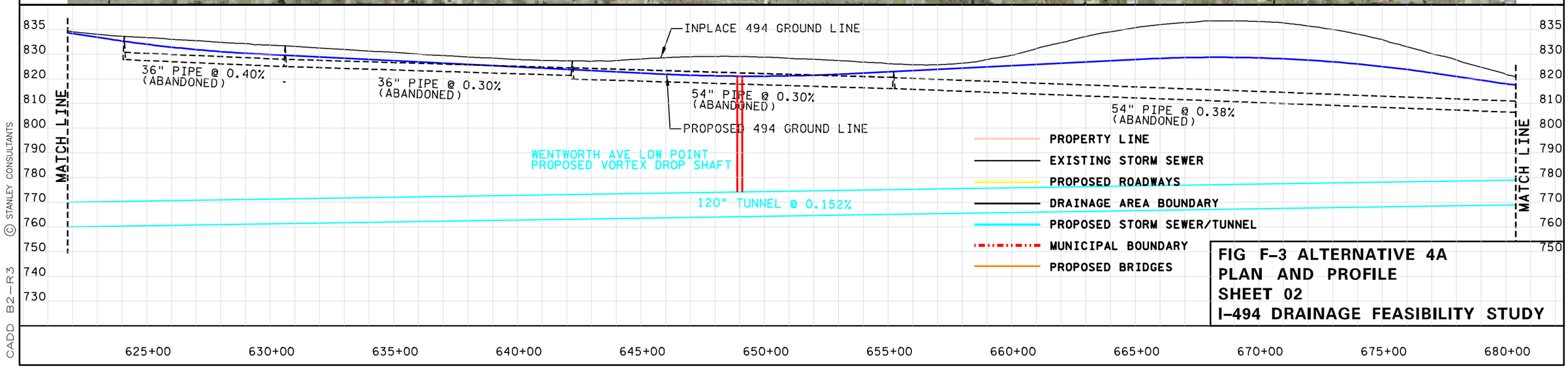

FIG F-3 ALTERNATIVE 4A
PLAN AND PROFILE
SHEET 02
I-494 DRAINAGE FEASIBILITY STUDY

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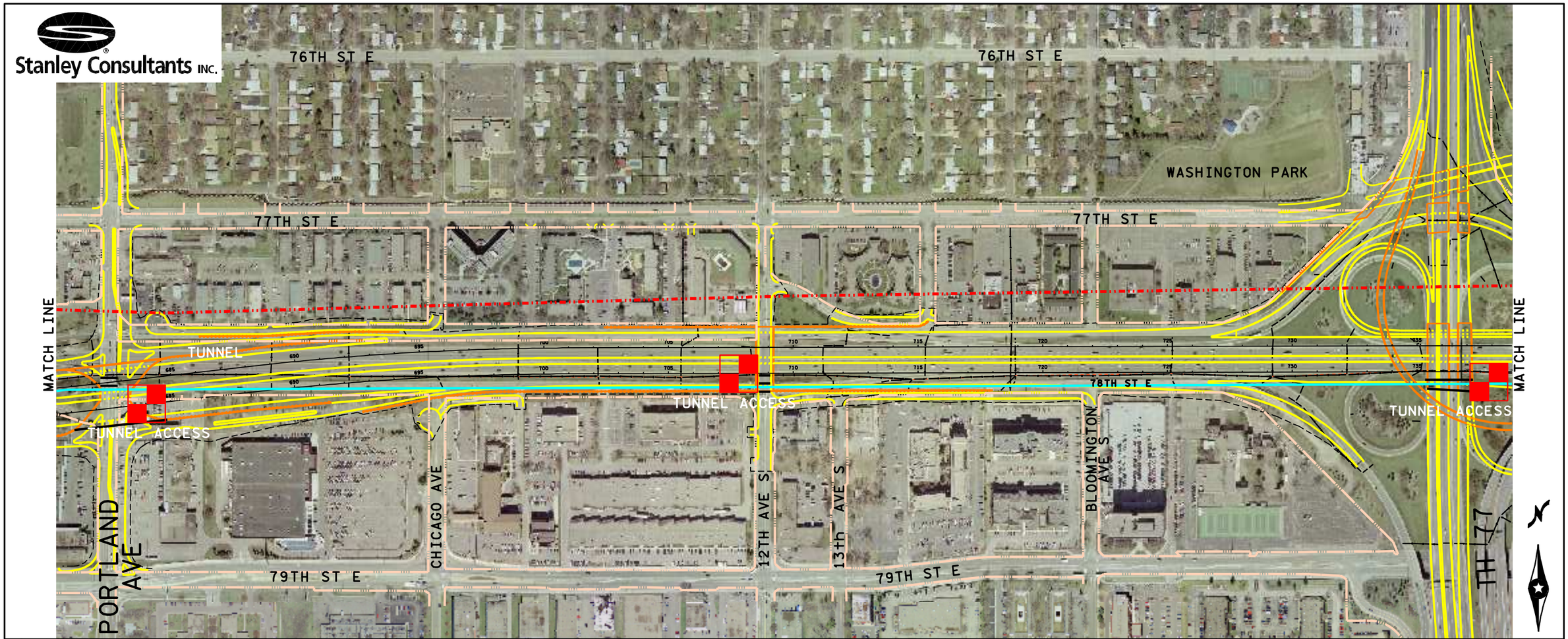

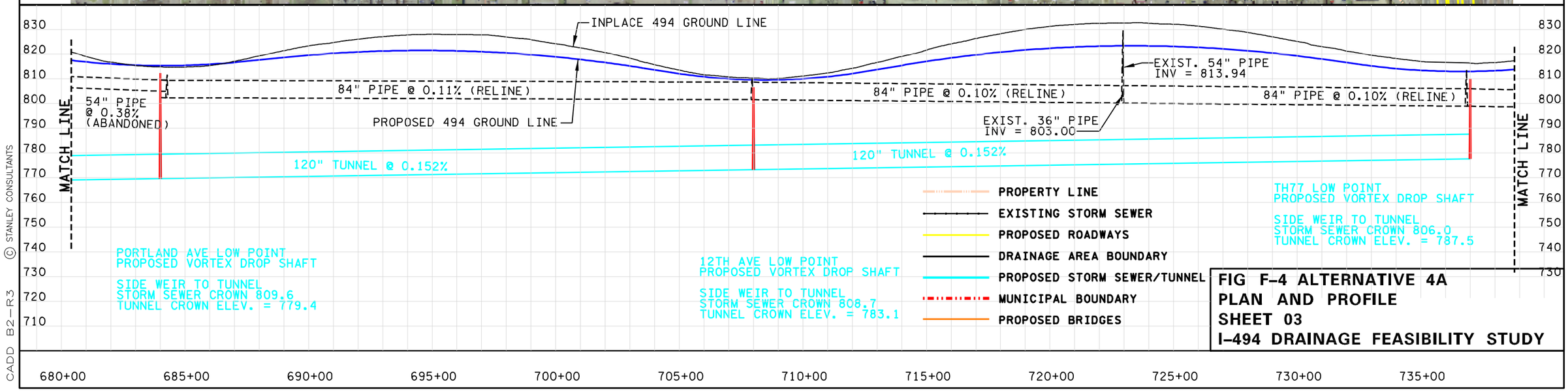

FIG F-4 ALTERNATIVE 4A
PLAN AND PROFILE
SHEET 03
I-494 DRAINAGE FEASIBILITY STUDY

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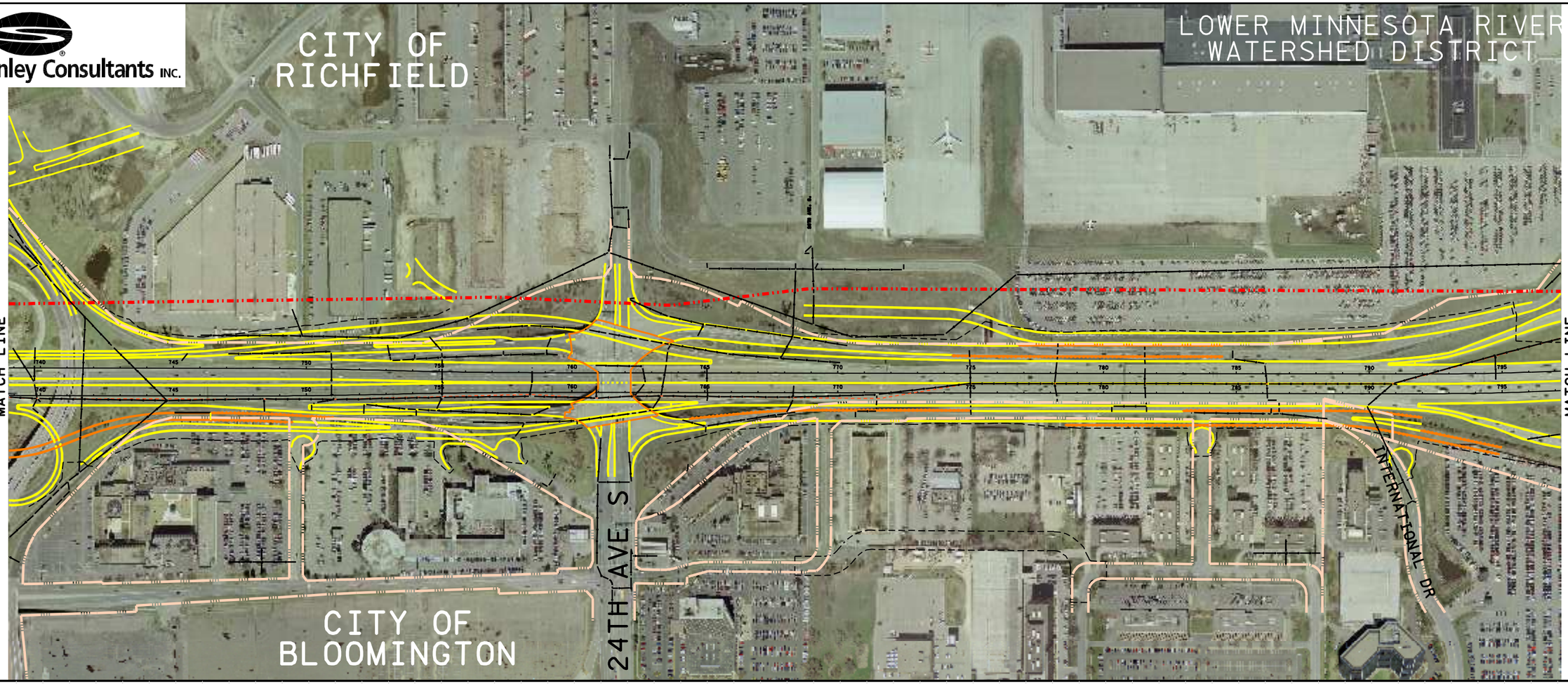

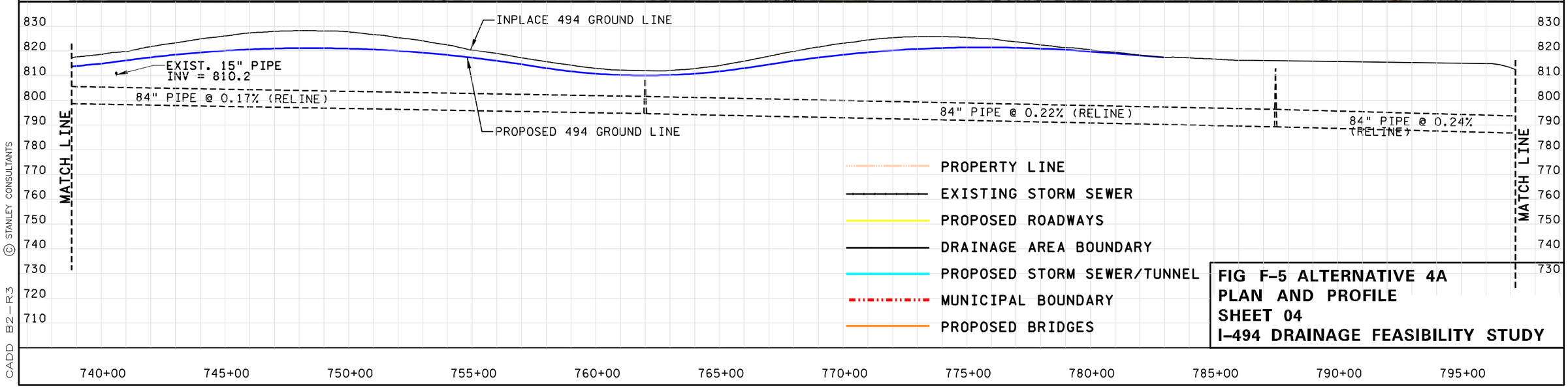

FIG F-5 ALTERNATIVE 4A
PLAN AND PROFILE
SHEET 04
I-494 DRAINAGE FEASIBILITY STUDY

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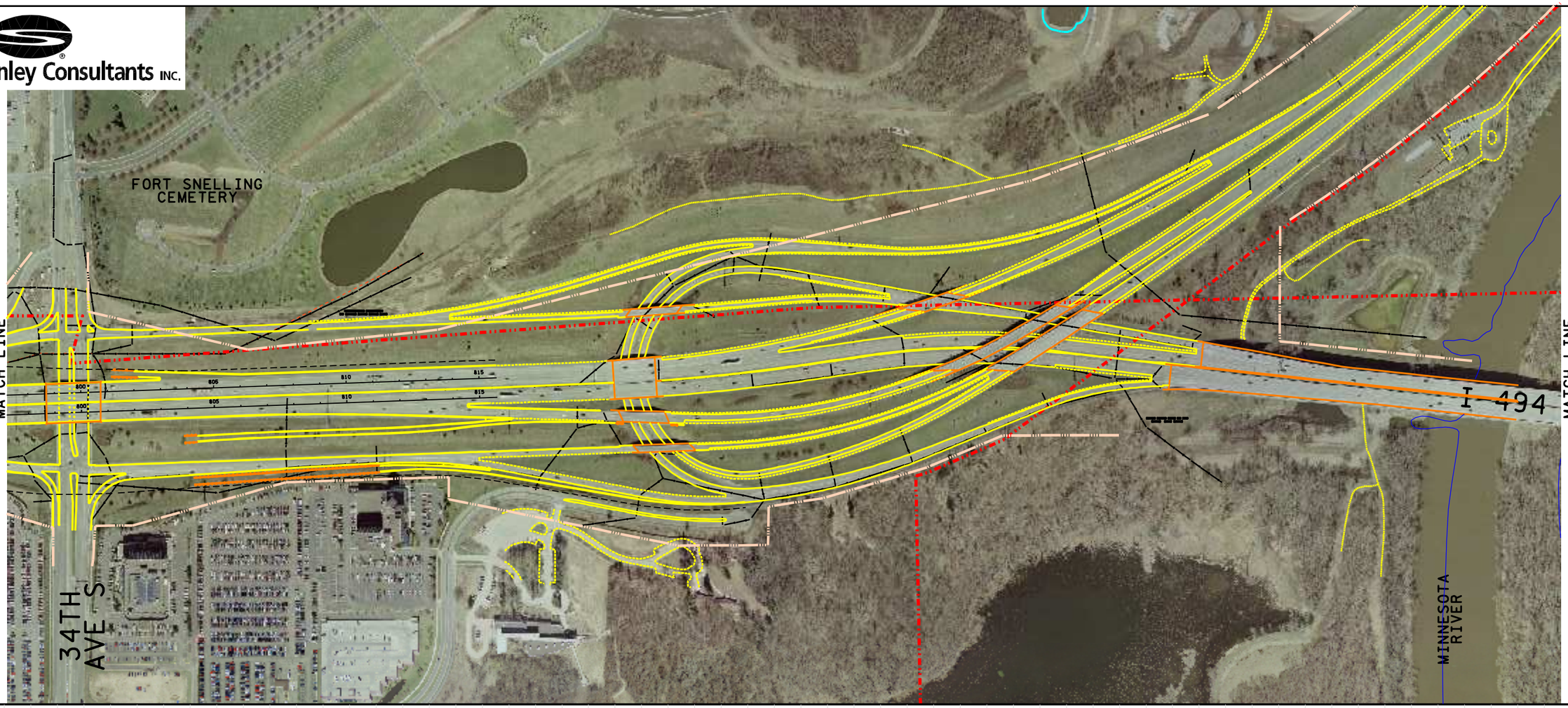

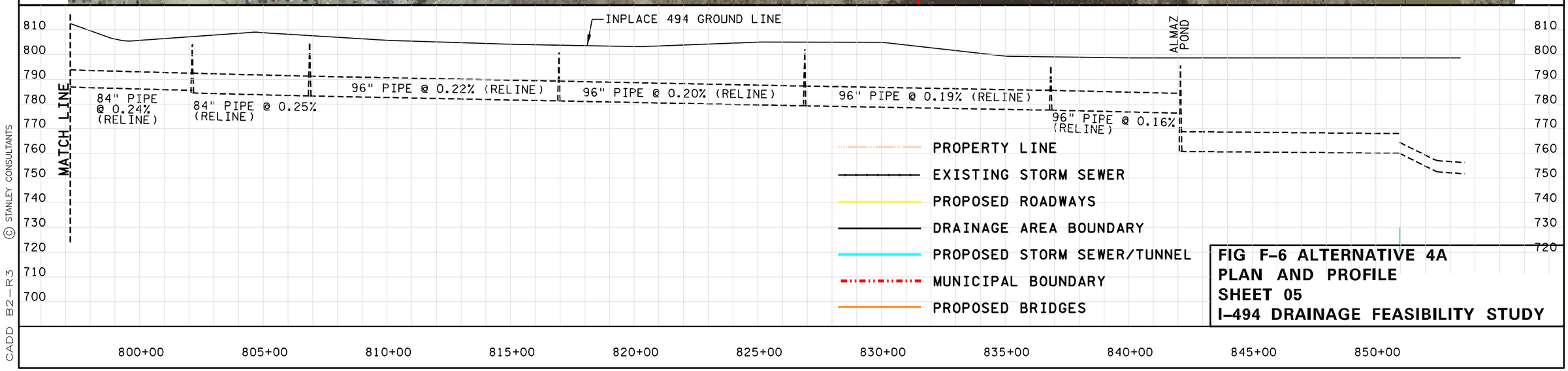

FIG F-6 ALTERNATIVE 4A
PLAN AND PROFILE
SHEET 05
I-494 DRAINAGE FEASIBILITY STUDY

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CADD B2-R3

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 4A	**Conveyance Tunnel Along I-35W**	Pickup some of the I-35W drainage			x		
		Less land needed			x		x
	Construct new 120" conveyance tunnel from Penn Avenue to TH 77. Route the tunnel south along I-35W to a new outfall location at the Minnesota River.	Improved water quality and sediment[2]			x	x	x
		Provides some rate control				x	
		MAC received okay to discharge to the river at a higher rate[3]				x	
		Richfield would not invest in a cost share option on a percentage basis		x			
	Uses Almaz Pond for Water quality and detention	Expensive					x
	Eliminates Penn Avenue pump station	Eliminate pump at Penn Ave.	x	x			x
	City of Bloomington owns various parcels along I-35W alignment - could be used for ponds	Various maintenance possibilities[5]		x			
		Water can drain into Almaz (state pond)					x
	Could also accommodate city drainage needs	Locally much easier	x	x			
	Outfall requires permission through US Fish & Wildlife Service (managed by City of Bloomington).	A payback may work with Bloomington[7]	x				
		Volume (rate control) is a problem[17]				x	
		Timeframe off with the City of Bloomington[7]	x				
	Future expansion to west of Penn is possible	Potential problems with US Fish and Wildlife[18]			x	x	
	New pond on I-35W at MN River (water quality & detention)	Maintenance concerns[14]	x				x
		Phosphorus removal still needed[11]				x	x
	Would also be able to drain areas adjacent to I-35W corridor	Storage concerns[13]	x			x	x
		Minimal effect on river or adjacent properties[12]					x
		Potential for additional storage at West Pond					x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION	STAKEHOLDER CONCERNS	
	This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington Richfield Nine Mile Lower MN Mn/DOT

Notes:

1. Water could still be taken down to the river and treated at those ponds.
2. Met water quality standard.
3. Based on the same information as Mn/DOT.
4. The pumps would go into the new system and would not need to be programmed on a hydrograph schedule.
5. These possibilities include: remote control vehicles, future technology, better street sweeping to prevent build up of sediment in the tunnel, and stormcepters.
6. This is already an expensive project. Even if the tunnel ends up costing more, it may be worth the extra expense to avoid having to acquire more land.
7. The City of Bloomington has a much shorter timeframe than Mn/DOT, and needs to provide funding
8. Massive political problems (Richfield's land use plan is already done).
9. This space is located in Bloomington by 24th and I-494 by the airport.
10. Because of all the current construction in these areas, the Cities need to know what land the ponds will be built on so they can to help protect this land.
11. It is needed for longer term detention downstream.
12. This assumes peak flow is allowed without detention.
13. Sediment may get into the tunnel and than it will need to be removed.
14. The tunnel is more difficult to clean out then the surface ponds.
15. Maintenance costs and techniques for buried storage of this magnitude are difficult to calculate because of the lack of existing comparable systems.
16. Not used.
17. Rate control standards are not met.
18. The ponds in Bloomington that are located below the bluff are currently not meeting capacity and need maintenance.
19. This includes land beyond the ROW.
20. This leads to flooding at the low points along the corridor.
21. Richfield would double the property cost listed on the Hennepin County Assessor's site.
22. The combination of cost and disruption to the Cities is very high.

CONCEPTUAL COST ESTIMATE WITH RETAINING WALLS
I-494 STORMWATER ALTERNATIVES STUDY

Apr-07

4A

PRE-CONSTRUCTION - ENGINEERING AND DESIGN	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES - INITIAL CONSTRUCTION	TOTAL ESTIMATED COST - INITIAL CONSTRUCTION	TOTAL ESTIMATED QUANTITIES - RECONSTRUCTION	TOTAL ESTIMATED COST - RECONSTRUCTION
ENGINEERING AND DESIGN	VARIES	VARIES	12.00%	$17,396,281.44	12.00%	$157,548.96
Assume a set percentage of the construction cost, less right-of-way and acquisition						
				$17,396,281.44		$157,548.96

PRE-CONSTRUCTION - RIGHT-OF-WAY	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES - INITIAL CONSTRUCTION	TOTAL ESTIMATED COST - INITIAL CONSTRUCTION	TOTAL ESTIMATED QUANTITIES - RECONSTRUCTION	TOTAL ESTIMATED COST - RECONSTRUCTION
RIGHT OF WAY and EASEMENTS	LUMP SUM	VARIES	$912,297.96	$912,297.96	$0.00	$0.00
RELOCATION and PROPERTY ESTABLISHMENT	LUMP SUM	VARIES	$0.00	$0.00	$0.00	$0.00
PAVEMENT REMOVAL and DEMOLITION	LUMP SUM	VARIES	$112,000.00	$112,000.00	$0.00	$0.00
				$924,297.96		$0.00

CONSTRUCTION - PHYSICAL CONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES - INITIAL CONSTRUCTION	TOTAL ESTIMATED COST - INITIAL CONSTRUCTION	TOTAL ESTIMATED QUANTITIES - RECONSTRUCTION	TOTAL ESTIMATED COST - RECONSTRUCTION
RCP STORM SEWER, 36" DIAMETER (surface drainage system excluded)	2503.511/0903S	LF	$65.00	0	$0.00	$0.00
RCP STORM SEWER, 48" DIAMETER (surface drainage system excluded)	2503.511/0904S	LF	$80.00	$59,680.00	$0.00	$0.00
RCP STORM SEWER, 60" DIAMETER (surface drainage system excluded)	2503.511/0905S	LF	$140.00	0	$0.00	$0.00
RCP STORM SEWER, 72" DIAMETER (surface drainage system excluded)	2503.511/0907S	LF	$220.00	$541,640.00	$0.00	$0.00
TUNNEL, 120" DIAMETER	LF	$3,000.00	0	$111,924,000.00	$0.00	$0.00
TUNNEL, 144" DIAMETER	LF	$3,600.00	0	$0.00	$0.00	$0.00
TUNNEL SHAFT HOLES	EACH	$285,000.00	2	$570,000.00	$0.00	$0.00
TUNNEL DRILL HOLE/ACCESS SHAFT	EACH	$115,000.00	48	$5,520,000.00	0	$0.00
DEWATERING (at shaft site, with tunnel alternatives only)	LUMP SUM	$115,000.00	1	$115,000.00	$0.00	$0.00
MICROTUNNEL, 42" DIAMETER	800' UNITS	$20,000.00	38	$760,000.00	8.5	$170,000.00
MICROTUNNEL ACCESS SHAFTS (every 800')	EACH	$1,000.00	0	$0.00	0	$0.00
FORCE MAIN, 16" STEEL	LF	$115,000.00	0	$0.00	0	$0.00
CATCH BASIN (ADDITIONAL DEPTH OF DRAINAGE STRUCTURES)	2504.503/2001S	LF	$80.00	0	$0.00	$0.00
RESURFACE TEMPORARY ACCESS LOCATIONS, 6"	2506.501/2006S	SF	$300.00	700	$0.00	$0.00
	2360.501/2206S	SF	$2.00	180000	$0.00	$0.00
REHABILITATE STORM SEWER, 27" DIAMETER	LF	$20.00	801	$16,020.00	801	$16,020.00
REHABILITATE STORM SEWER, 36" DIAMETER	LF	$30.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 42" DIAMETER	LF	$40.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 54" DIAMETER	LF	$50.00	1652	$82,600.00	1652	$82,600.00
REHABILITATE STORM SEWER, 72" DIAMETER	LF	$60.00	0	$0.00	0	$0.00
REHABILITATE STORM SEWER, 84" DIAMETER	LF	$70.00	7811	$546,770.00	7811	$546,770.00
REHABILITATE STORM SEWER, 96" DIAMETER	LF	$80.00	0	$0.00	0	$0.00
POND LOCATION NUMBER 1, PENN AVENUE						
EXCAVATION	2105.515/0001C	CUBIC YARD	$8.00	0	$0.00	$0.00
TURF ESTABLISHMENT		ACRE	$8,000.00	0	$0.00	$0.00
PERIMETER FENCING	LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10TH X 14W CONCRETE BOX CULVERT SECTIONS	2412.511/2106	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	2401.501/0831	LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2411.604/0011C	CUBIC YARD	$250.00	0	$0.00	0	$0.00
RETAINING WALL	2411.604/0011C	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
POND LOCATION NUMBER 2, WENTWORTH AVENUE						
EXCAVATION	2105.515/0001C	CUBIC YARD	$8.00	0	$0.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$8,000.00	0	$0.00	0	$0.00
PERIMETER FENCING	LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10TH X 14W CONCRETE BOX CULVERT SECTIONS	2412.511/2106	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	2401.501/0831	LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2411.604/0011C	CUBIC YARD	$250.00	0	$0.00	0	$0.00
RETAINING WALL	2411.604/0011C	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
POND LOCATION NUMBER 3, PORTLAND AVENUE						
EXCAVATION	2105.515/0001C	CUBIC YARD	$8.00	0	$0.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$8,000.00	0	$0.00	0	$0.00
PERIMETER FENCING	LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10TH X 14W CONCRETE BOX CULVERT SECTIONS	2412.511/2106	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE LINER (To seal against groundwater infiltration)		SQUARE FOOT	$3.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	2401.501/0831	LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2411.604/0011C	CUBIC YARD	$250.00	0	$0.00	0	$0.00
RETAINING WALL	2411.604/0011C	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
POND LOCATION NUMBER 4, T+77						
EXCAVATION	2105.515/0001C	CUBIC YARD	$8.00	0	$0.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$8,000.00	0	$0.00	0	$0.00
PERIMETER FENCING	LINEAR FOOT	$12.00	0	$0.00	0	$0.00
10TH X 14W CONCRETE BOX CULVERT SECTIONS	2412.511/2106	LINEAR FOOT	$1,100.00	0	$0.00	0	$0.00
HDPE LINER (To seal against groundwater infiltration)		SQUARE FOOT	$3.00	0	$0.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	2401.501/0831	LINEAR FOOT	$220.00	0	$0.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2411.604/0011C	CUBIC YARD	$250.00	0	$0.00	0	$0.00
RETAINING WALL	2411.604/0011C	SQUARE FOOT	$35.00	0	$0.00	0	$0.00
WEST POND EXPANSION (Or new pond for Alternative 4A)						
EXCAVATION	2105.515/0001C	CUBIC YARD	$8.00	112000	$896,000.00	0	$0.00
TURF ESTABLISHMENT		ACRE	$8,000.00	0.56	$4,480.00	0	$0.00
PERIMETER FENCING	LINEAR FOOT	$12.00	2300	$27,600.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.501/0831	CUBIC YARD	$250.00	150	$37,500.00	40	$10,000.00
RETAINING WALL	2411.604/0011C	SQUARE FOOT	$35.00	9000	$315,000.00	4500	$157,500.00
PUMP STATION, 3.5 CFS	LUMP SUM	$100,000.00	0	$0.00	0	$0.00
				$125,857,510.00		$1,094,080.00
SUBTOTAL				$24,181,502.00	20.00%	$218,816.00
				$144,969,012.00		$1,312,908.00
CONTINGENCY			20.00%			

CONSTRUCTION - CONSTRUCTION MANAGEMENT	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
CONSTRUCTION MANAGEMENT	VARIES	VARIES	5.00%	$7,248,450.60
Assume a set percentage of the construction cost, less right-of-way and acquisition				
				$7,248,450.60

POST-CONSTRUCTION - MAINTENANCE	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
MAINTENANCE	LUMP SUM	$580,000.00	0	$0.00
Present value of an annual sum				
				$0.00

TOTAL PROJECT COST, INITIAL CONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES, YEAR 40	TOTAL ESTIMATED COST, PRESENT VALUE OF YEAR 40 CONSTRUCTION
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$17,396,281.44		$797,593.79
PRE-CONSTRUCTION - RIGHT-OF-WAY				$924,297.96		$0.00
CONSTRUCTION - PHYSICAL CONSTRUCTION				$144,969,012.00		$6,647,448.22
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$7,248,450.60		$332,372.41
POST-CONSTRUCTION - MAINTENANCE				$0.00		$0.00
				$171,118,042.00		$7,777,514.41

TOTAL PROJECT COST, YEAR 40 RECONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST, PRESENT VALUE OF YEAR 40 CONSTRUCTION
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$797,593.79
PRE-CONSTRUCTION - RIGHT-OF-WAY				$0.00
CONSTRUCTION - PHYSICAL CONSTRUCTION				$6,647,448.22
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$332,372.41
POST-CONSTRUCTION - MAINTENANCE				$0.00
				$7,777,514.41

TOTAL PROJECT COST, 80-YEAR LIFE CYCLE, 2007 DOLLARS	UNIT	UNIT COST	TOTAL ESTIMATED QUANTITIES	0
PRE-CONSTRUCTION - ENGINEERING AND DESIGN				$18,193,875.23
PRE-CONSTRUCTION - RIGHT-OF-WAY				$924,297.96
CONSTRUCTION - PHYSICAL CONSTRUCTION				$151,616,460.22
CONSTRUCTION - CONSTRUCTION MANAGEMENT				$7,580,823.01
POST-CONSTRUCTION - MAINTENANCE				$580,000.00
				$178,895,556.41

MAINTENANCE COSTS
I-494 STORMWATER ALTERNATIVES STUDY

ALTERNATIVE	1C	2C	2D	2E	2F	4A	5A
SEDIMENT ACCUMULATION	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)
PENN		3300	3300	3300	3300		
WENTWORTH		26500	2100	2100	2100		
PORTLAND		10000	1400	1400	1400		
TH 77		29100	3800	3800	3800		
ALMAZ POND	26100	31300	89600	89600	89600	74100	26100
WEST POND	74100	0	0	0	0	26100	74100
	100200	100200	100200	100200	100200	100200	100200
20-year volume [ac-ft]	2.30	2.30	2.30	2.30	2.30	2.30	2.30

SEDIMENT COLLECTION

Use upstream catch basins to collect sediment prior to entry into mainline storm sewer *

Number of Intakes, EA	175	175	175	175	175	175	525
Additional height per intake, FT	4	4	4	4	4	4	4
Assumed height of additional intakes, FT	700	700	700	700	700	700	2100
At 6' diameter, provided storage per unit, CF	113	113	113	113	113	113	113
Total Intake Storage Provided, CF	19775	19775	19775	19775	19775	19775	59325
Total Intake Storage Provided, CY	732	732	732	732	732	732	2197
Catch basin volume [ac-ft]	0.45	0.45	0.45	0.45	0.45	0.45	1.36

* Assume equivalent distribution over each ponding area

Sediment to be removed from sumps **

PENN		2475	2475	2475	2475		
WENTWORTH		19875	1575	1575	1575		
PORTLAND		7500	1050	1050	1050		
TH 77		21825	2850	2850	2850		
ALMAZ POND	19575	23475	67200	67200	67200	55575	19575
WEST POND	55575					19575	55575
20-year volume to Ponds	1.73	1.73	1.73	1.73	1.73	1.73	1.73
20-year volume to Catch Basins	0.58	0.58	0.58	0.58	0.58	0.58	0.58
20-year volume total	2.30	2.30	2.30	2.30	2.30	2.30	2.30

** Assume 25% of sediment is captured in the catch basins

Maintenance Assumptions

Catch Basins

20% Intakes cleaned annually
6,262.50 Sediment Cleaned Annually from sumps
6 Intakes per hour per crew
5.83 Crew Hours, say 8 hours
$ 2,000.00 Cost per hour per crew, including traffic control
$ 2.55 per cubic foot removed
$ 68.98 per cubic yard removed from Catch Basins
$ 16,000.00 say $ 20,000.00 per year

Ponds and Sumps Clean 20% of sumps annually
$ 137.96 Cost per yard removed from Sumps
$ 68.98 Cost per yard removed from Ponds

PENN		$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34		$ -
WENTWORTH		$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58		$ -
PORTLAND		$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05		$ -
TH 77		$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57		$ -

West Pond Clean every 10 years
$ 68.98 per cubic yard removed from Ponds

ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
WEST POND (I-35W OUTLET POND)	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40

SEDIMENT LOCATION	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST
INTAKES/CATCH BASINS	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 60,000.00
PENN	$ -	$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34	$ -	$ -
WENTWORTH	$ -	$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58	$ -	$ -
PORTLAND	$ -	$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05	$ -	$ -
TH 77	$ -	$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57	$ -	$ -
ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
OUTLET POND	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40
ANNUAL TOTAL	$ 29,600.00	$ 49,403.59	$ 36,708.98	$ 36,708.98	$ 36,708.98	$ 29,500.00	$ 69,600.00
PRESENT VALUE	$ 580,000.00	$ 968,000.00	$ 719,000.00	$ 719,000.00	$ 719,000.00	$ 580,000.00	$ 1,364,000.00

5% Inflation Rate
80 Year Economic Lifespan

Appendix G

Alternative 5A – Storage Tunnel with Gravity Outfall

Outfall Location

The outfall location for the Alternative 5 storage tunnel is the West Pond and Almaz Pond site, where a water quality pond will be expanded at West Pond. The Almaz Pond outfall, located just north of I-494 on the Minnesota River, will continue as the outfall for the re-used portion of the existing drainage system. The outfalls are located within the Lower Minnesota River Watershed District (LMRWD).

Conveyance System

A storage tunnel presents an alternative to surface and near-surface ponding as described in Alternatives 2D and 2F. Adequate belowground storage of discharges exceeding the existing pipe capacity will eliminate surcharging and flooding and will regulate discharge to the Minnesota River according to the LMRWD rate control requirements.

A three-mile, 12-foot-diameter storage tunnel was designed to receive runoff from Penn Avenue and overflow from the trunk drainage system from the Wentworth Avenue low point through the TH 77 low point. The existing trunk sewer drains the corridor from TH 77 to the East. The volume of the tunnel is 41 acre-feet. The storage tunnel discharges through a 3.5-ft diameter micro-tunneled gravity outlet to the West Pond.

An overflow structure was placed at each surface low point to divert excess discharge to the tunnel. The design was balanced to preserve capacity in downstream pipes for downstream inflows into the replaced and existing trunk systems. At each drop structure, an orifice was placed in the pipe to limit downstream discharge and develop head to force discharge over side weirs (two each with a 15-ft crest length). Flow over the weirs would discharge to vortex-type drop shaft down to the storage tunnel.

Rate Control

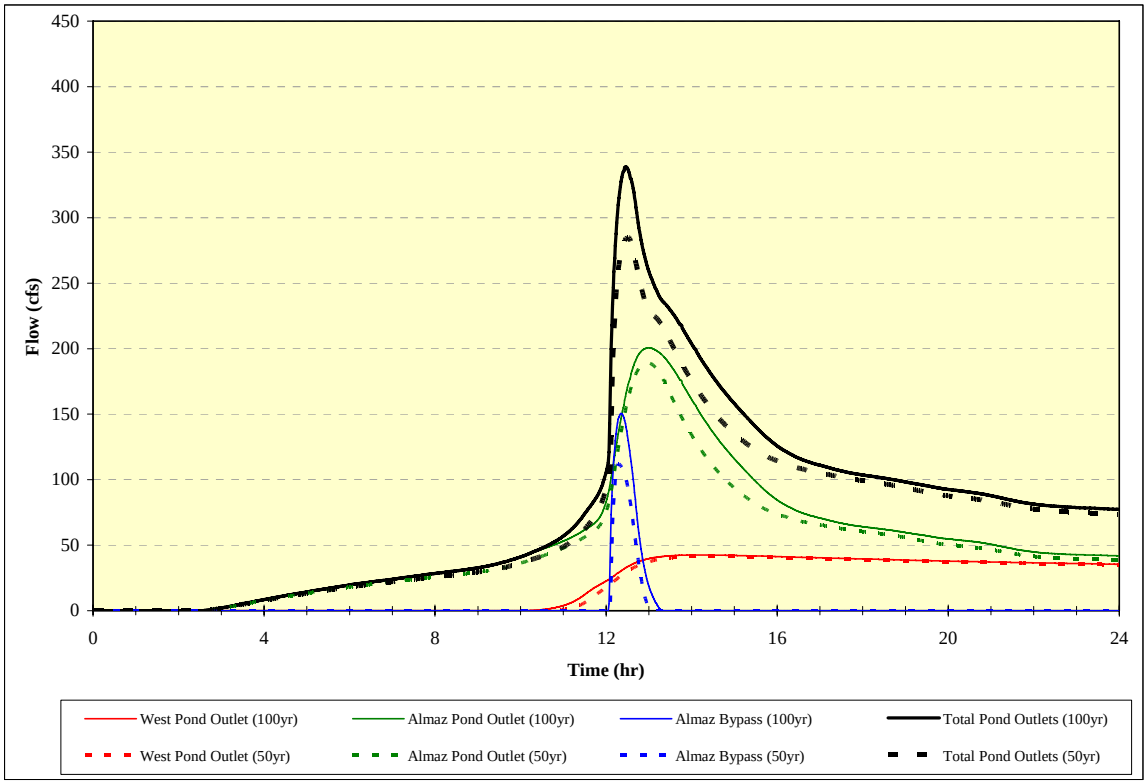
By diverting flows in excess of the existing system capacity to the storage tunnel, peak discharge rates are kept below the existing peaks (see Wenck 2007a, Appendix H).

Table G-1 Alternative 5A Peak Flow Rates[1] (cfs)

Location	Rainfall Frequency	
	50-yr, 24-hr	**100-yr, 24-hr**
Total System	285	339
Almaz Outlet	189	201
Almaz Bypass	112	151
West Pond	42	42

The Alternative 5A discharge to the Minnesota River is shown in the combined hydrograph in Figure G-1 below.

[1] Note that the total system peak flow rate is smaller than the sums of the individual locations due to the different times to peak; see Figure G-1.



Individual Outfall, and Combined Hydrographs for Alternative 5A Discharge to the Minnesota River
Figure G-1

Water Quality

In Alternative 5A, the 2.5-inch storm will result in approximately 16 acre-feet of runoff directed to the West Pond, and 36 acre-feet to Almaz Pond. This will overload Almaz (19 acre-feet) and reduce its effectiveness to about 42 percent phosphorus removal. (Due to site constraints, Almaz Pond cannot be expanded from its existing size.) West Pond is sized with an area of 6.1 acres and an average depth of 5.4 feet to provide 33 ac-ft of dead storage so that the total is 52 ac-ft as required by the LMRWD rules. The oversizing of the West Pond will provide 57 percent phosphorus removal for an overall project average of 47 percent, after accounting for 20 percent loss of storage volume due to sedimentation. With the oversizing at West Pond, further increases in size will not provide a net 50 percent removal with reasonably sized ponds. (Doubling the size of West Pond would only reach 48 percent removal.) If Almaz Pond is kept free of sediment accumulation, the modeled system performance would meet the 50 percent threshold. These figures are based on the PondNet pond water quality model (Walker, 1987), which was used to develop the MPCA design guidance (MPCA, 1989.) See Appendix H for details of the analysis.

In order to achieve the full 50 percent phosphorus removal, it may be possible to install the partial flow diversion from the trunk line upstream of Almaz Pond over to West Pond, as in Alternatives 2D and 2F. Alternatively, optimization of the low point diversion structures might be capable of balancing the volumes between the two ponds.

The West Pond outlet to the Minnesota River was modeled as a 100-ft weir which resulted in a 0.3-ft bounce during the 100-year event. The weir was enlarged to minimize unintentional storage since additional detention storage (rate control) was not needed. Detail design would address the exact outlet configuration with consideration for the effects of the discharge velocity on navigation and channel stability on the Minnesota River. See Appendix H for concerns raised about the outfall by the Lower Minnesota River Watershed District.

Sediment

Sediment from the I-494 drainage system would collect in Almaz and West Ponds, roughly in proportion to the flow volume. The total suspended sediment load for the I-494 drainage system is estimated as 400,000 lb/yr; this represents a total volume of roughly 5,000 ft^3/yr, or 2.3 ac-ft over a twenty-year period. (This is based on a typical total suspended solids concentration of 300 mg/L, and equivalent to about 900 lb/acre.) The sediment accumulation in Almaz Pond and in West Pond would reach about 1.6 and 0.6 acre-feet, respectively after 20 years of operation, much less than the 20 percent loss assumed in the PondNet phosphorus removal calculations and the LMRWD (NURP) standard. These volumes correspond to average depths of 0.5 feet and 0.1 feet, respectively.

Maintenance

As per the sedimentation discussion in Section 3, even though Mn/DOT does not use sand for snow and ice control along this section of highway, the accumulation of sediment still occurs. This material finds its way to the site on the tires of vehicles entering from sandy areas, as wind blown debris from off site, or from open topped loads of sand and aggregate that traverse the highway.

Regardless of the drainage Alternative selected, the total amount of sediment generated over the 438 acre site will remain constant. This is estimated at 4,468 cubic feet of material each year. Although a consistent street sweeping program can capture half of this material, our estimates assume that all suspended solids are conveyed to the storm sewer system.

For Alternatives 5A, the need to capture sediment upstream of the storage tunnel is paramount, so catch basins at each storm sewer intake location are used to capture the bulk of the suspended solids. The balance of the load will be conveyed within the tunnel and transported to West Pond. As the existing storm sewer system downstream of TH 77 will be utilized, a portion of the total load will be deposited in Almaz Pond (see Sediment section above).

Our assumption is that both Almaz and West Ponds will be cleaned of accumulated sediment every ten years. As with other existing detention basins, cleaning will occur during the winter, when water levels are low and access by tracked excavators and dump trucks can be made over frozen ground.

We have further assumed that 20% of the individual catch basins will be cleaned each year. This will be accomplished through the use of purpose built vacuum trucks, accompanied by necessary and required support vehicles and traffic control.

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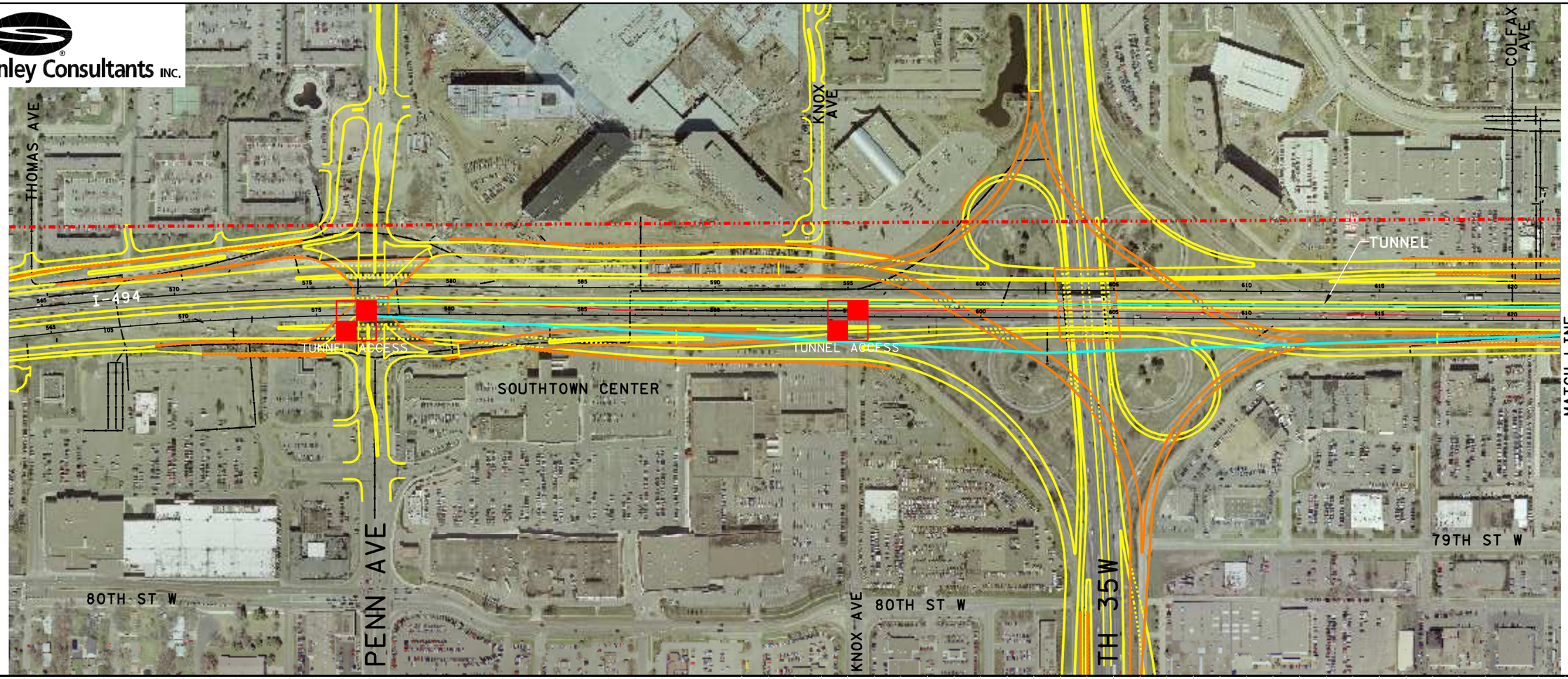

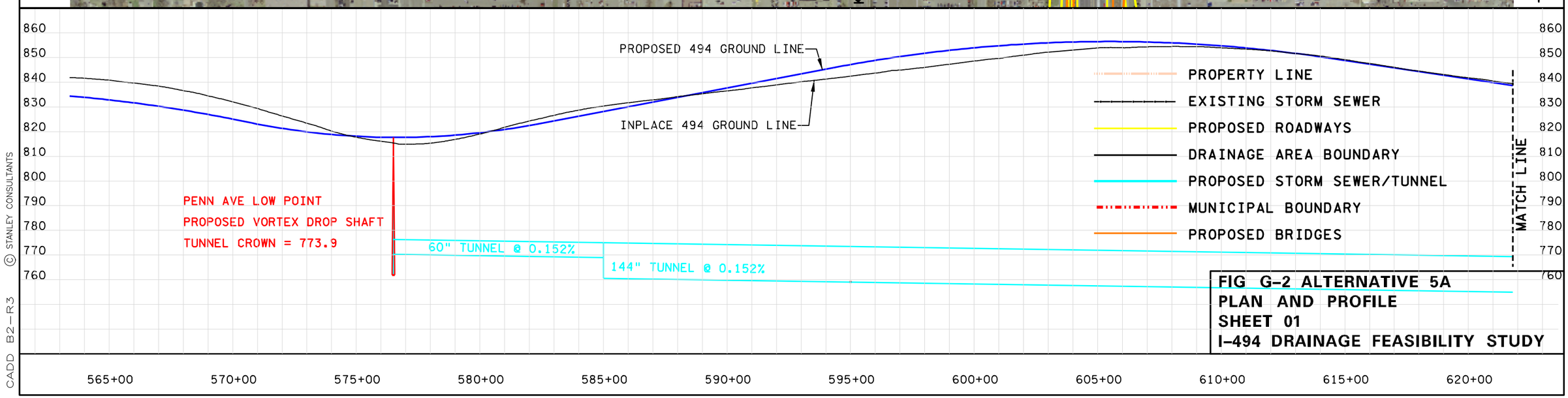

FIG G-2 ALTERNATIVE 5A
PLAN AND PROFILE
SHEET 01
I-494 DRAINAGE FEASIBILITY STUDY

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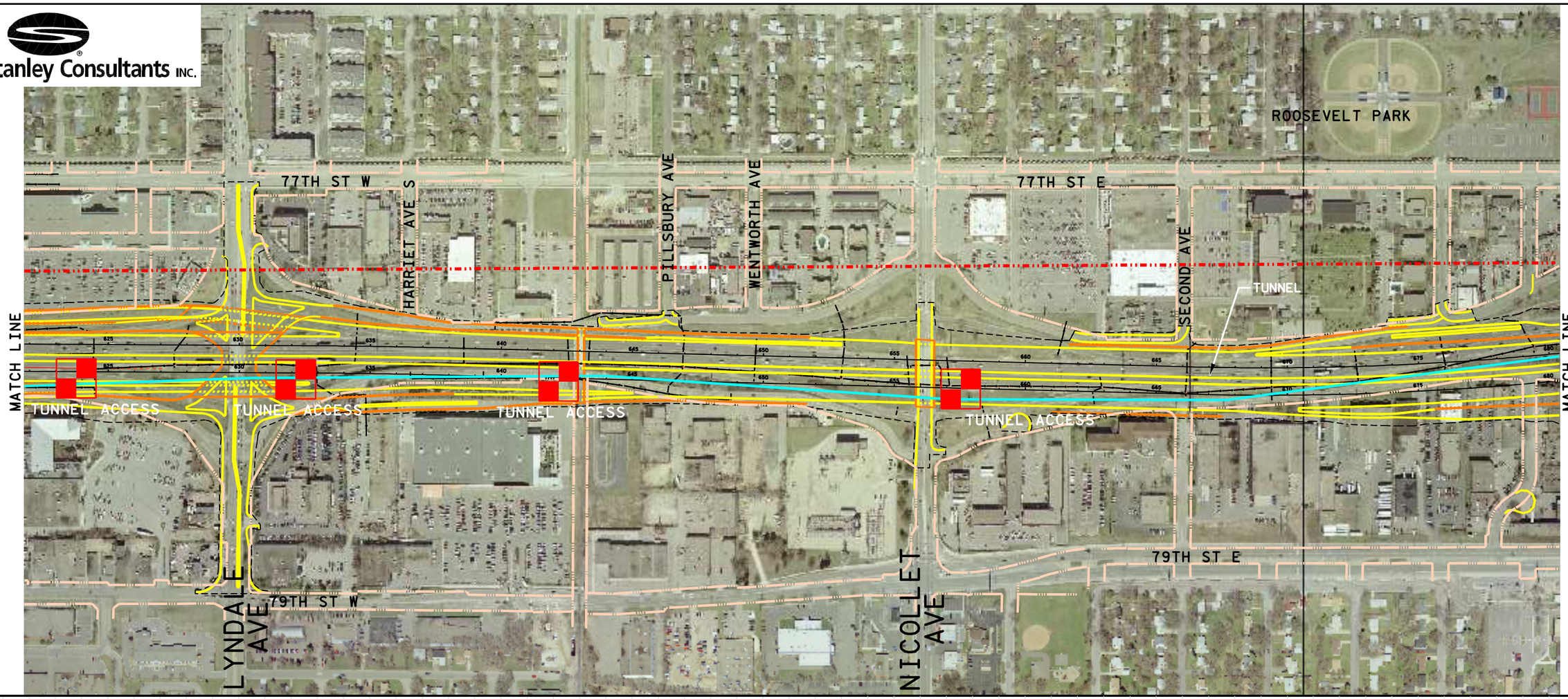

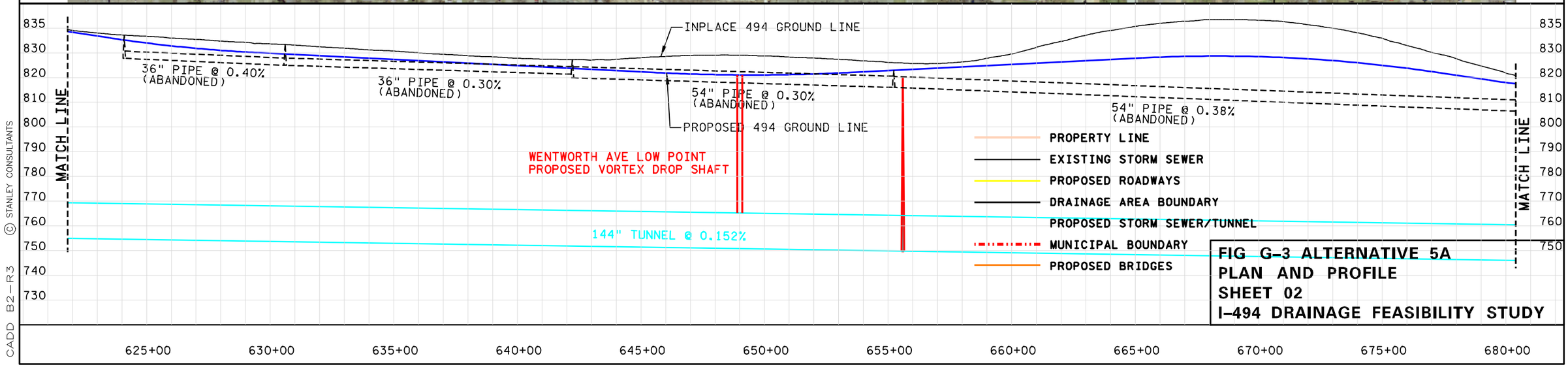

FIG G-3 ALTERNATIVE 5A
PLAN AND PROFILE
SHEET 02
I-494 DRAINAGE FEASIBILITY STUDY

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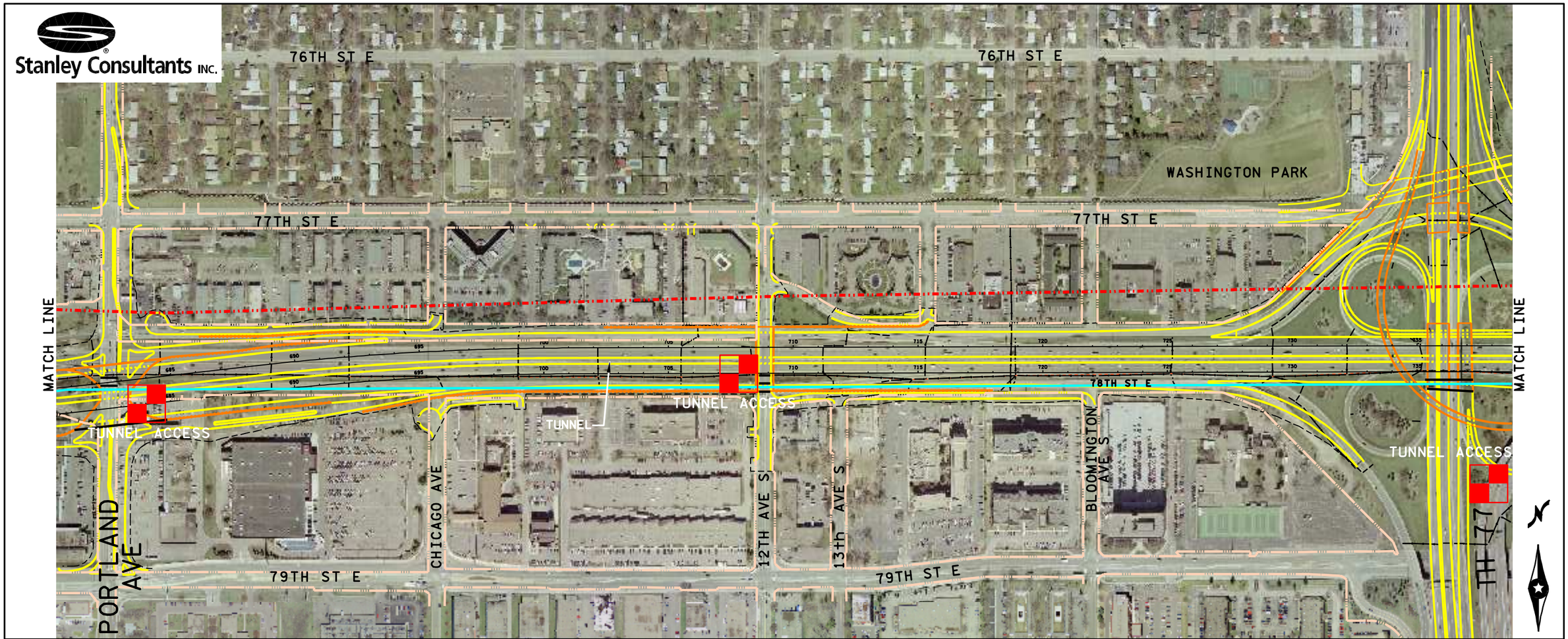

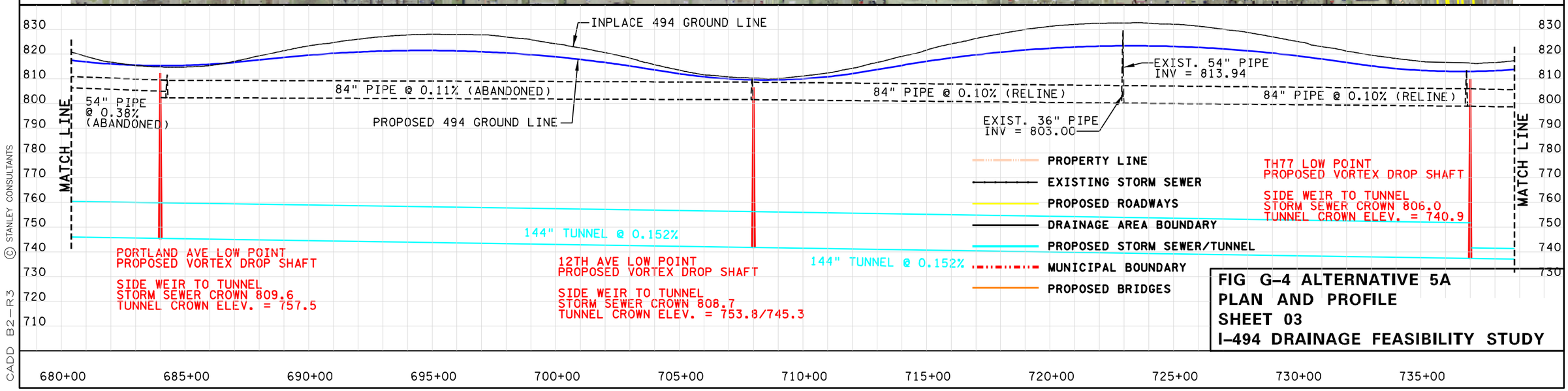

FIG G-4 ALTERNATIVE 5A
PLAN AND PROFILE
SHEET 03
I-494 DRAINAGE FEASIBILITY STUDY

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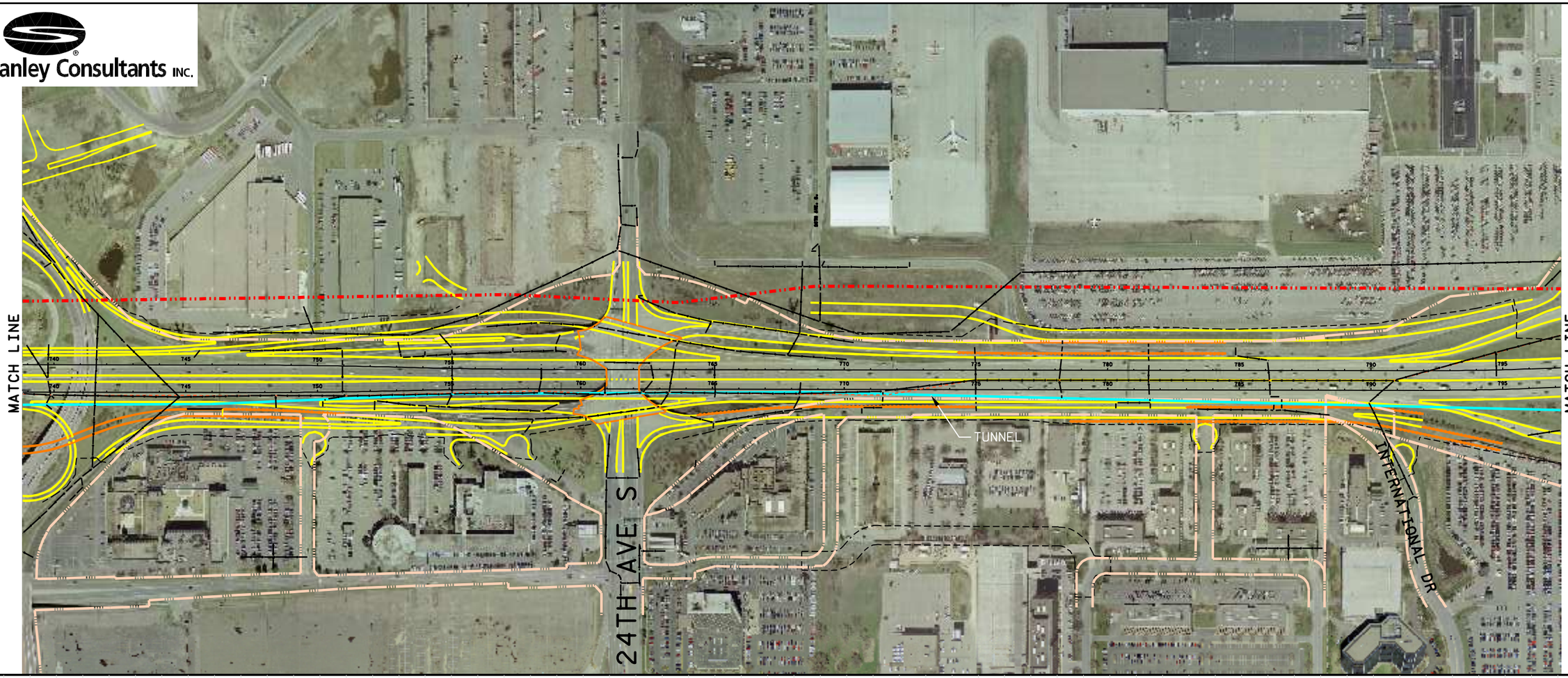

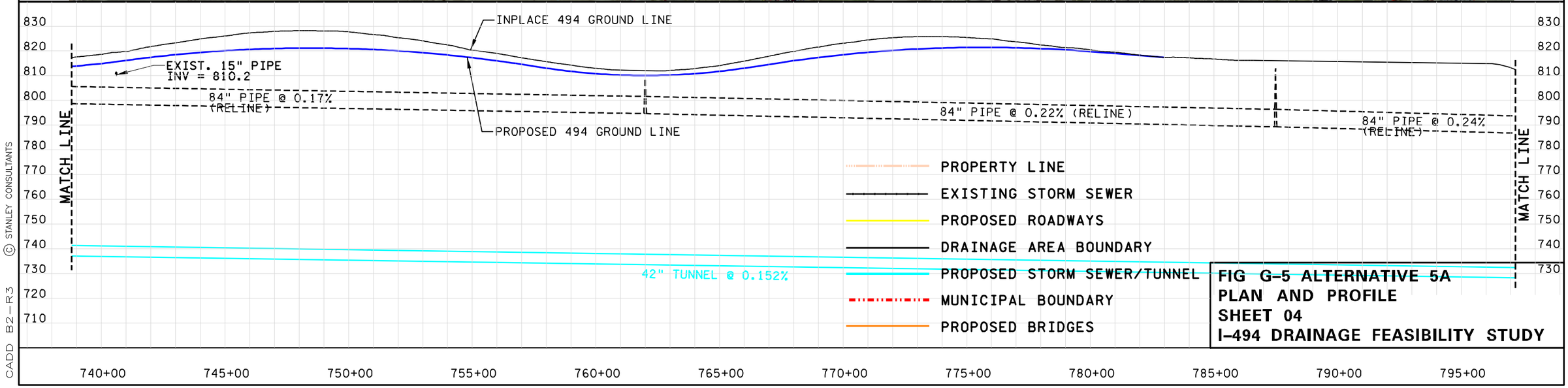

FIG G-5 ALTERNATIVE 5A
PLAN AND PROFILE
SHEET 04
I-494 DRAINAGE FEASIBILITY STUDY

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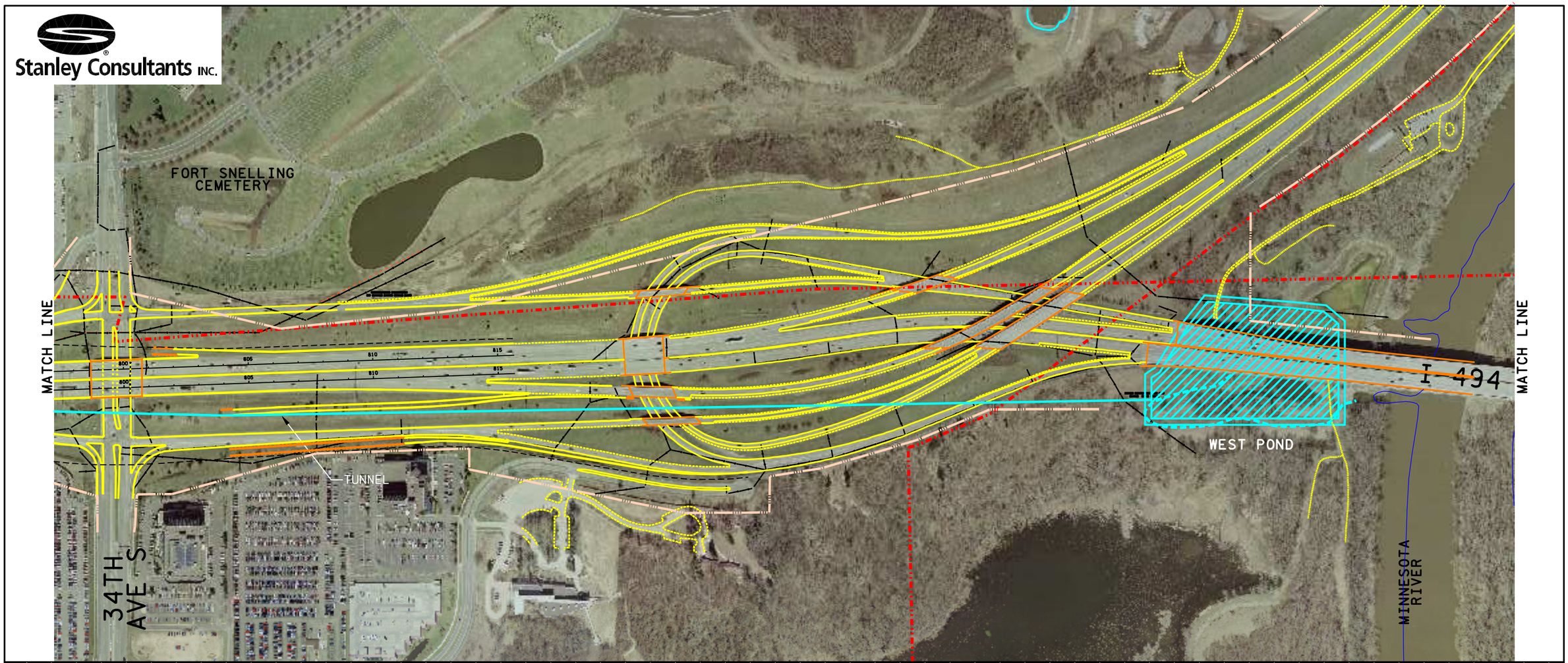

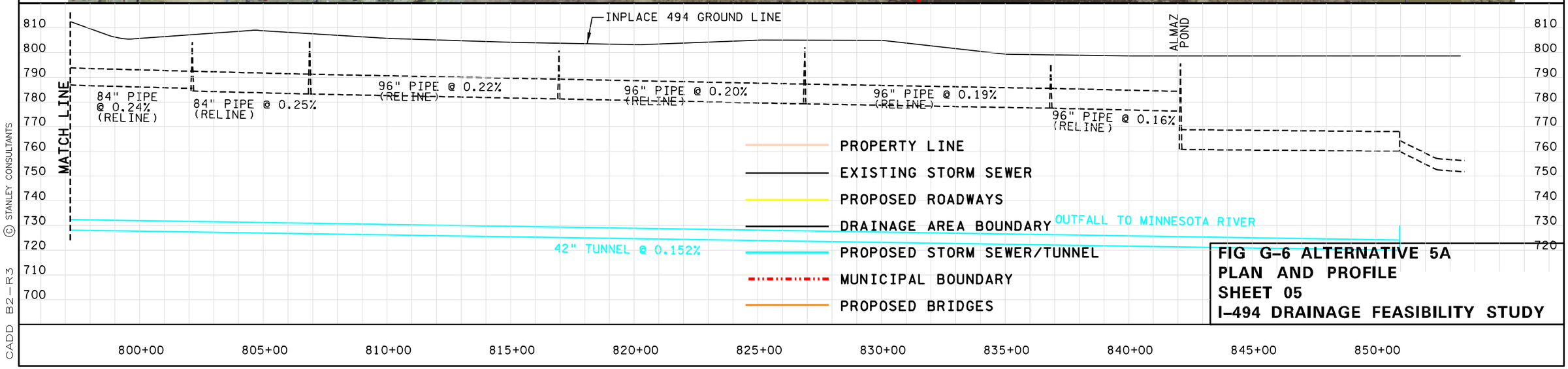

FIG G-6 ALTERNATIVE 5A
PLAN AND PROFILE
SHEET 05
I-494 DRAINAGE FEASIBILITY STUDY

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I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION		STAKEHOLDER CONCERNS: This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington	Richfield	Nine Mile	Lower MN	Mn/DOT
Alternative 5A	**Storage Tunnel**	Lower MN Watershed permit required				x	
	Construct new 144" storage and conveyance tunnel from Penn Avenue to 12th Avenue South. Rate control outfall is 42" microtunnel from 12th Avenue South to West Pond.	Volume reduction on municipal boundary basis[1]			x	x	
		Less land needed			x		x
		Improved water quality and sediment[2]			x	x	
		West pond can handle the water					x
		Provides some rate control				x	x
	Penn Ave. pump gone	MAC received okay to discharge to the river at a higher rate[3]				x	
	Future expansion to the west possible	May be cheaper since no need to acquire land[6]	x	x			x
	Uses West pond for water quality	Logical area for buried storage		x			x
	Almaz pond will be used for water quality	Eliminate pump at Penn Ave.[4]	x	x			x
		Various maintenance possibilities[5]		x			x
		Water can drain into Almaz (state pond)					x
		Locally much easier	x	x			
		Volume (rate control) is a problem[17]				x	
		Richfield would not invest in a cost share option on a percentage basis		x			
		Phosphorus removal still needed[11]				x	
		Expensive					x
		Minimal effect on river or adjacent properties[12]					x
		Storage concerns[13]	x			x	x
		Maintenance concerns[14]	x				x

I-494 Stormwater Alternatives Study - Stakeholder Concerns

ALTERNATIVE DESCRIPTION	STAKEHOLDER CONCERNS	
	This information is a summary of comments received through the stakeholder coordination process (meetings, conversations, and correspondance). Not all notes apply to each Alternative	Bloomington Richfield Nine Mile Lower MN Mn/DOT

Notes:

1. Water could still be taken down to the river and treated at those ponds.
2. Met water quality standard.
3. Based on the same information as Mn/DOT.
4. The pumps would go into the new system and would not need to be programmed on a hydrograph schedule.
5. These possibilities include: remote control vehicles, future technology, better street sweeping to prevent build up of sediment in the tunnel, and stormcepters.
6. This is already an expensive project. Even if the tunnel ends up costing more, it may be worth the extra expense to avoid having to acquire more land.
7. The City of Bloomington has a much shorter timeframe than Mn/DOT, and needs to provide funding
8. Massive political problems (Richfield's land use plan is already done).
9. This space is located in Bloomington by 24th and I-494 by the airport.
10. Because of all the current construction in these areas, the Cities need to know what land the ponds will be built on so they can to help protect this land.
11. It is needed for longer term detention downstream.
12. This assumes peak flow is allowed without detention.
13. Sediment may get into the tunnel and than it will need to be removed.
14. The tunnel is more difficult to clean out then the surface ponds.
15. Maintenance costs and techniques for buried storage of this magnitude are difficult to calculate because of the lack of existing comparable systems.
16. Not used.
17. Rate control standards are not met.
18. The ponds in Bloomington that are located below the bluff are currently not meeting capacity and need maintenance.
19. This includes land beyond the ROW.
20. This leads to flooding at the low points along the corridor.
21. Richfield would double the property cost listed on the Hennepin County Assessor's site.
22. The combination of cost and disruption to the Cities is very high.

CONCEPTUAL COST ESTIMATE WITH RETAINING WALLS
I-494 STORMWATER ALTERNATIVES STUDY

Apr-07

5A

PRE-CONSTRUCTION - ENGINEERING AND DESIGN	UNIT	UNIT COST	TOTAL ESTIMATED COST - INITIAL CONSTRUCTION	TOTAL ESTIMATED QUANTITIES - RECONSTRUCTION	TOTAL ESTIMATED COST - RECONSTRUCTION
ENGINEERING AND DESIGN	VARIES	VARIES	$10,743,962.40	12.00%	$220,042.08
Assume a set percentage of the construction cost, less right-of-way and acquisition					
			$10,743,962.40		$220,042.08

PRE-CONSTRUCTION - RIGHT-OF-WAY	UNIT	UNIT COST	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
RIGHT OF WAY and EASEMENTS	LUMP SUM	VARIES	$812,297.96	$0.00	$0.00
RELOCATION and REESTABLISHMENT	LUMP SUM	VARIES	$0.00	$312,297.96	$0.00
PAVEMENT REMOVAL and DEMOLITION	LUMP SUM	VARIES	$112,000.00	$112,000.00	$0.00
			$924,297.96		$0.00

CONSTRUCTION - PHYSICAL CONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
RCP STORM SEWER, 30" DIAMETER (surface drainage system excluded)	2503.511160303	LF	$80.00	0	$0.00
RCP STORM SEWER, 48" DIAMETER (surface drainage system excluded)	2503.511160403	LF	$90.00	0	$0.00
RCP STORM SEWER, 60" DIAMETER (surface drainage system excluded)	2503.511160603	LF	$150.00	0	$0.00
RCP STORM SEWER, 72" DIAMETER (surface drainage system excluded)	2503.511160723	LF	$180.00	1850	$277,500.00
			$220.00	6218	$1,368,960.00
TUNNEL, 120" DIAMETER		LF	$0.00	0	$0.00
TUNNEL, 144" DIAMETER		LF	$5,000.00	19050	$95,175,000.00
TUNNEL SHAFT HOLES		EACH	$296,000.00	2	$592,000.00
TUNNEL DRILL HOLE/ACCESS SHAFT		EACH	$115,000.00	17	$1,955,000.00
PORTAL WORK SITE (with tunnel alternatives only)		LUMP SUM	$115,000.00	1	$115,000.00
MICROTUNNEL 42" DIAMETER		500' UNITS	$20,000.00	17	$340,000.00
MICROTUNNEL ACCESS SHAFTS (every 500')		LF	$1,000.00	6660	$6,660,000.00
		EACH	$116,000.00	18	$2,088,000.00
FORCE MAIN, 16" STEEL	2504.603/02016	LF	$60.00	0	$0.00
CATCH BASIN (ADDITIONAL DEPTH OF DRAINAGE STRUCTURE)	2503.501/03003	LF	$360.00	2100	$756,000.00
RESURFACE TEMPORARY ACCESS LOCATIONS, 6"	2503.501 2232C	SF	$2.20	180000	$396,000.00
REHABILITATE STORM SEWER, 27" DIAMETER		LF	$80.00	801	$64,080.00
REHABILITATE STORM SEWER, 30" DIAMETER		LF	$90.00	0	$0.00
REHABILITATE STORM SEWER, 42" DIAMETER		LF	$40.00	0	$0.00
REHABILITATE STORM SEWER, 60" DIAMETER		LF	$80.00	0	$0.00
REHABILITATE STORM SEWER, 84" DIAMETER		LF	$90.00	0	$0.00
REHABILITATE STORM SEWER, 96" DIAMETER		LF	$70.00	11621	$813,470.00
POND LOCATION NUMBER 1, PENN AVENUE			$90.00	0	$0.00
EXCAVATION	2105.515/00010	CUBIC YARD			
TURF ESTABLISHMENT		ACRE	$8.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$8,000.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.611/12100	LINEAR FOOT	$12.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	2411.604/00110	SQUARE FOOT	$1,100.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.601/03003	CUBIC YARD	$220.00	0	$0.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$250.00	0	$0.00
			$35.00	0	$0.00
POND LOCATION NUMBER 2, WENTWORTH AVENUE					
EXCAVATION	2105.515/00010	CUBIC YARD			
TURF ESTABLISHMENT		ACRE	$8.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$8,000.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.611/12100	LINEAR FOOT	$12.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	2411.604/00110	SQUARE FOOT	$1,100.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.601/03003	CUBIC YARD	$220.00	0	$0.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$250.00	0	$0.00
			$35.00	0	$0.00
POND LOCATION NUMBER 3, PORTLAND AVENUE					
EXCAVATION	2105.515/00010	CUBIC YARD			
TURF ESTABLISHMENT		ACRE	$8.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$8,000.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.611/12100	LINEAR FOOT	$12.00	0	$0.00
HDPE LINER (To seal against groundwater infiltration)		SQUARE FOOT	$1,100.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	2411.604/00110	SQUARE FOOT	$220.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.601/03003	CUBIC YARD	$250.00	0	$0.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00
POND LOCATION NUMBER 4, 1-77					
EXCAVATION	2105.515/00010	CUBIC YARD			
TURF ESTABLISHMENT		ACRE	$8.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$8,000.00	0	$0.00
10'H X 14'W CONCRETE BOX CULVERT SECTIONS	2412.611/12100	LINEAR FOOT	$12.00	0	$0.00
HDPE LINER (To seal against groundwater infiltration)		SQUARE FOOT	$1,100.00	0	$0.00
HDPE DETENTION STORAGE CELLS (Box Culvert Equivalent)	2411.604/00110	SQUARE FOOT	$220.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.601/03003	CUBIC YARD	$250.00	0	$0.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$35.00	0	$0.00
WEST POND EXPANSION (Or new pond for Alternative 4A)					
EXCAVATION	2105.515/00010	CUBIC YARD			
TURF ESTABLISHMENT		ACRE	$8.00	0	$0.00
PERIMETER FENCING		LINEAR FOOT	$8,000.00	0	$0.00
CONTROL STRUCTURE (Structural Concrete)	2401.601/03003	CUBIC YARD	$12.00	10	$120.00
RETAINING WALL	2411.604/00110	SQUARE FOOT	$250.00	4500	$1,125,000.00
			$35.00	0	$0.00
PUMP STATION, 3.5 CFS		LUMP SUM	$100,000.00	0	$0.00
					$74,010,850.00
SUBTOTAL					$14,802,170.00
CONTINGENCY				20.00%	$20,533,020.00
					$1,833,884.00

CONSTRUCTION - CONSTRUCTION MANAGEMENT	UNIT	UNIT COST	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
CONSTRUCTION MANAGEMENT	VARIES	VARIES	$4,476,651.00	5.00%	$91,684.20
Assume a set percentage of the construction cost, less right-of-way and acquisition					
			$4,476,651.00		$91,684.20

POST-CONSTRUCTION - MAINTENANCE	UNIT	UNIT COST	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST
MAINTENANCE	LUMP SUM	VARIES	$1,394,000.00	0	$0.00
Present value of an annual sum					
			$1,364,000.00		$0.00

TOTAL PROJECT COST, INITIAL CONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES, YEAR 40	TOTAL ESTIMATED COST, PRESENT VALUE OF YEAR 40 CONSTRUCTION
			$10,743,962.40		$1,302,321.33
			$924,297.96		$0.00
			$89,533,020.00		$10,852,677.72
			$4,476,651.00		$542,833.86
			$1,364,000.00		$0.00
			$107,041,931.36		$12,697,832.93

PRE-CONSTRUCTION - ENGINEERING AND DESIGN
PRE-CONSTRUCTION - RIGHT-OF-WAY
CONSTRUCTION - PHYSICAL CONSTRUCTION
CONSTRUCTION - CONSTRUCTION MANAGEMENT
POST-CONSTRUCTION - MAINTENANCE

TOTAL PROJECT COST, YEAR 40 RECONSTRUCTION	UNIT	UNIT COST	TOTAL ESTIMATED COST	TOTAL ESTIMATED QUANTITIES	TOTAL ESTIMATED COST, PRESENT VALUE OF YEAR 40 CONSTRUCTION
			$1,302,321.33		0
			$0.00		
			$10,852,677.72		
			$542,833.86		
			$0.00		
			$12,697,832.93		

PRE-CONSTRUCTION - ENGINEERING AND DESIGN
PRE-CONSTRUCTION - RIGHT-OF-WAY
CONSTRUCTION - PHYSICAL CONSTRUCTION
CONSTRUCTION - CONSTRUCTION MANAGEMENT
POST-CONSTRUCTION - MAINTENANCE

TOTAL PROJECT COST, 80-YEAR LIFE CYCLE, 2007 DOLLARS	UNIT	UNIT COST	TOTAL ESTIMATED COST
			$12,046,283.73
			$924,297.96
			$100,385,597.72
			$5,016,284.89
			$1,364,000.00
			$119,739,564.29

PRE-CONSTRUCTION - ENGINEERING AND DESIGN
PRE-CONSTRUCTION - RIGHT-OF-WAY
CONSTRUCTION - PHYSICAL CONSTRUCTION
CONSTRUCTION - CONSTRUCTION MANAGEMENT
POST-CONSTRUCTION - MAINTENANCE

MAINTENANCE COSTS
I-494 STORMWATER ALTERNATIVES STUDY

ALTERNATIVE	1C	2C	2D	2E	2F	4A	5A
SEDIMENT ACCUMULATION	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)	20 Year Volume Required (CF)
PENN		3300	3300	3300	3300		
WENTWORTH		26500	2100	2100	2100		
PORTLAND		10000	1400	1400	1400		
TH 77		29100	3800	3800	3800		
ALMAZ POND	26100	31300	89600	89600	89600	74100	26100
WEST POND	74100	0	0	0	0	26100	74100
	100200	100200	100200	100200	100200	100200	100200
20-year volume [ac-ft]	2.30	2.30	2.30	2.30	2.30	2.30	2.30

SEDIMENT COLLECTION

Use upstream catch basins to collect sediment prior to entry into mainline storm sewer *

Number of intakes, EA	175	175	175	175	175	175	525
Additional height per intake, FT	4	4	4	4	4	4	4
Assumed height of additional intakes, FT	700	700	700	700	700	700	2100
At 6' diameter, provided storage per unit, CF	113	113	113	113	113	113	113
Total Intake Storage Provided, CF	19775	19775	19775	19775	19775	19775	59325
Total Intake Storage Provided, CY	732	732	732	732	732	732	2197
Catch basin volume [ac-ft]	0.45	0.45	0.45	0.45	0.45	0.45	1.36

* Assume equivalent distribution over each ponding area

Sediment to be removed from sumps **

PENN		2475	2475	2475	2475		
WENTWORTH		19875	1575	1575	1575		
PORTLAND		7500	1050	1050	1050		
TH 77		21825	2850	2850	2850		
ALMAZ POND	19575	23475	67200	67200	67200	55575	19575
WEST POND	55575					19575	55575

** Assume 25% of sediment is captured in the catch basins

20-year volume to Ponds	1.73	1.73	1.73	1.73	1.73	1.73	1.73
20-year volume to Catch Basins	0.58	0.58	0.58	0.58	0.58	0.58	0.58
20-year volume total	2.30	2.30	2.30	2.30	2.30	2.30	2.30

Maintenance Assumptions

Catch Basins

20% Intakes cleaned annually
6,262.50 Sediment Cleaned Annually from sumps
6 Intakes per hour per crew
5.83 Crew Hours, say 8 hours
$ 2,000.00 Cost per hour per crew, including traffic control
$ 2.55 per cubic foot removed
$ 68.98 per cubic yard removed from Catch Basins
$ 16,000.00 say $ 20,000.00 per year

Ponds and Sumps Clean 20% of sumps annually
$ 137.96 Cost per yard removed from Sumps
$ 68.98 Cost per yard removed from Ponds

PENN		$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34		$ -
WENTWORTH		$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58		$ -
PORTLAND		$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05		$ -
TH 77		$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57		$ -

West Pond Clean every 10 years
$ 68.98 per cubic yard removed from Ponds

ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
WEST POND (I-35W OUTLET POND)	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40

SEDIMENT LOCATION	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST	ANNUAL COST
INTAKES/CATCH BASINS	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 60,000.00
PENN	$ -	$ 1,264.67	$ 2,529.34	$ 2,529.34	$ 2,529.34	$ -	$ -
WENTWORTH	$ -	$ 10,155.69	$ 1,609.58	$ 1,609.58	$ 1,609.58	$ -	$ -
PORTLAND	$ -	$ 3,832.34	$ 1,073.05	$ 1,073.05	$ 1,073.05	$ -	$ -
TH 77	$ -	$ 11,152.10	$ 2,912.57	$ 2,912.57	$ 2,912.57	$ -	$ -
ALMAZ POND	$ 2,500.60	$ 2,998.80	$ 8,584.43	$ 8,584.43	$ 8,584.43	$ 7,099.40	$ 2,500.60
OUTLET POND	$ 7,099.40	$ -	$ -	$ -	$ -	$ 2,500.60	$ 7,099.40
ANNUAL TOTAL	$ 29,600.00	$ 49,403.59	$ 36,708.98	$ 36,708.98	$ 36,708.98	$ 29,600.00	$ 69,600.00
PRESENT VALUE	**$ 580,000.00**	**$ 968,000.00**	**$ 719,000.00**	**$ 719,000.00**	**$ 719,000.00**	**$ 580,000.00**	**$ 1,364,000.00**

5% Inflation Rate
80 Year Economic Lifespan

Appendix H

References and Back-up Documentation

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- Figure of Drainage Basins along I-494

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Memorandum

1800 Pioneer Creek Center, Maple Plain, MN 55359
Phone: 763-479-4200 Fax: 763-479-4242

Wenck

To: Files

From: Chris Meehan, P.E., John R. Thene P.E.

Date: May 27, 2004

Subject: MnDOT 494 Drainage Corridor Study
XP-SWMM Model Review and Initial Model Results

SUMMARY

This memorandum is prepared to document review and analysis of the I-494 drainage system according to the Wenck tasks outlined in the March 10, 2004 meeting minutes.

The base model established in Section 1.2 has been reviewed for known changes in drainage area, revisions to high points and subwatershed divides, and for basic input parameters. The model covers a total drainage area of 438 acres in 38 subwatersheds; the average subwatershed size is 11.5 acres (Table 1). The models do not include detailed drainage system modeling (i.e. to catch basin level). The level of detail in the base model is considered adequate to answer the large-scale questions of the drainage feasibility study, including storage, conveyance and water quality.

Our model review and initial XP-SWMM simulations for the I-494 corridor further demonstrate that:

- Corridor drainage conditions and connections should be analyzed with the drainage model as revised herein. The base model was taken from the 2002 Tunnel Feasibility Study and revised according to known changes in tributary drainage areas.
- The existing drainage system is undersized for proposed roadway conditions.
- No model has been provided for the existing roadway.
- The existing system could be utilized to drain the future I-494 corridor from Sta. 748+60 (400 feet east of TH 77) to the Minnesota River, without additional ponding. A new system would be required to drain I-494 from Penn Avenue through the TH 77 interchange. If minor surcharging were accepted, the TH 77 drainage can also be accommodated by the existing system.
- Analysis of the upstream end of the existing drainage system shows that the pipes are undersized, eliminating an alternative utilizing existing infrastructure upstream of Portland Avenue.
- The flooded volume (combined for all low points) for the 100-year storm is 41 ac-ft. Live storage needed to utilize the existing system will likely exceed this value.
- The water-quality volume (pond dead volume) requirement is 52 ac-ft.
- Initial model results are summarized in this memo.

1 MODEL DESCRIPTION AND REVIEW

1.1 Tunnel Feasibility Study Model Inputs Review

Wenck received two XP-SWMM models of the corridor hydrology and hydraulics from the 2002 Tunnel Feasibility Study (TFS). The models were labeled as:

Model Name	Description
Ex2mod.xp	Existing drainage system model (for the 2-year event) with the drainage system extending from the Minnesota River though Colfax Avenue (roughly 1500 feet East of 35W). Does not include Penn Avenue intersection drainage.
Opt1_50yr.xp	TFS (2002) Option 1 model (for the 50-year event). Model is extended upstream to include the Penn Avenue drainage. Includes drainage to both the existing trunk storm sewer system and to a parallel deep tunnel. Will be used as basis for future model runs.

SRF provided additional background information regarding the TFS modeling following initiation of this study, including:

- A revised Table 4.1 for the TFS. The table clarified inconsistencies between the XP-SWMM model input files and the original Table 4.1 provided in the TFS Report.
- Base TFS subwatershed maps (Scale 1" = 100') including the 38 subwatershed delineations used in developing the XP-SWMM models and the TFS evaluation of the tunnel alternatives. These maps clarify the origin of the model inputs, and serve as a basis for new drainage area base maps.
- The TFS base maps show individual subwatershed areas from the model corresponding to the node names in the model. Other subwatershed input parameters (time of concentration and curve number) for each subwatershed were also provided on the drawings.
- SRF has clarified that both models provided are based on the proposed highway geometrics (as of May, 2000). An "existing conditions" model with both the existing highway geometrics and the existing drainage system was not available.
- The 35W interchange is proposed to drain to the south and is therefore not included in the model.
- SRF called out two areas (10.9 and 3.3 acres) that should be reviewed to determine whether they contribute to the I-494 system.

1.2 Review of Model Input Parameters

The 24-hour rainfall amounts are 5.3 and 5.9 inches for the 50- and 100-year return intervals, respectively. The standard SCS Type-II rainfall hyetographs were used to distribute the design storm precipitation amounts over the 24-hour storm duration. The time step used for the simulations is 15 seconds.

For each time step, and each subwatershed, infiltration and runoff depths are determined by the SCS Curve Number method. The Curve Number for each subwatershed is selected to characterize the pervious and impervious cover of each subwatershed. The

Curve Number controls the infiltration amount, and thus volume of runoff. The runoff discharge rate is determined by the precipitation intensity, Curve Number, and time of concentration determined for each subwatershed.

We performed the following checks of the model inputs:

- The overall project drainage boundaries were compared with boundaries provided by in Watershed Management Plans from Richfield and Bloomington. The overall boundaries are in agreement with the TFS maps.
- We determined high point stationing from the current highway profile. These were compared with the drainage divides on the TFS subwatershed maps. Where there were differences, the subwatershed areas on the maps and in the model were adjusted accordingly.
- Areas for all 37 subwatersheds were planimetered from the TFS subwatershed maps as a basic check of the model inputs.
- Curve Numbers are generally high, indicating the highly imperviousness of the I-494 corridor and contributing subwatersheds.
- The vertical profile is known to have changed since the TFS was completed; the times of concentration along the corridor were checked to address changes to the vertical alignment. Due to the already short times of concentrations (25 of 38 are 15 minutes or less), small changes in slope, and with MnDOT's minimum time of concentration standard of 7 minutes, no changes in time of concentration to the models were required.

The drainage system drains the corridor itself plus some adjoining residential and commercial property and roadways. Three other connections drain to the system. They are as follows:

1. Wood Lake connection from the City of Richfield, which was modeled as a constant 13 cfs inflow.
2. Park n' Go stormwater pond outlet.
3. The Veterans Administration (VA) drainage area was assumed in the model to drain directly to the existing 96-inch trunk sewer line.

Subwatershed characteristics included in the models are summarized in Table 1. Revisions to subwatershed drainage area – relative to the areas in the original model – determined through our review are noted. A new base model was developed for the analysis contained herein. The changes made to the Opt1_50yr.xp model are:

- Inclusion of the Penn Avenue subwatershed (14.5 acres).
- Removal of the 10.9-acre drainage area (from Subwatersheds 9-5 and 10-4), which drains south to the Bloomington system.
- Removal of the 3.3 acre "Airport Medical Clinic" site which drains to the MAC system. The subwatershed determined form the TFS base maps was only 3.0 acres, therefore watershed 9-5 was reduced from 13.2 to 10.2 acres.
- Increased drainage area from the Veterans Administration site (40 to 53 acres).

- Removed 12.6 acres which were included in the model twice. This area is the Park-N-Go lot which is modeled as its own subwatershed and pond.
- Increased subwatersheds 9-1, 9-2, 9-3 to cover a gap in coverage between them and subwatershed 8-5.

Table 1. Subwatershed Characteristics[1]

Sub ID	Subwatershed (XP-SWMM Node ID)	Model Node Street Location	Drainage Area [ac]	Revised Drainage Area [ac]	Curve Number, CN [--]	Revised Curve Number, CN [--]	Time of Concentration Tc (min)
0	Penn	Penn Ave.	14.5		98		10
1	2 - 1	Colfax Ave	3.6		98		7
2	2 - 2	Colfax Ave	4.0		95		15
3	2 - 3	Colfax Ave	12.2		93		15
4	3 - 1	Garfield Ave	8.3		98		7
5	3 - 2	Garfield Ave	3.9		93		13
6	3 - 3	Garfield Ave	3.0		94		13
7	4 - 1	Pleasant Ave	12.4		98		10
8	4 - 2	Pleasant Ave	12.0		96		16
9	4 - 3	Pleasant Ave	1.5		93		12
10	5 - 1	Nicollet Ave	5.1		82		12
11	5 - 2	Nicollet Ave	1.4		87		10
12	5 - 3	Nicollet Ave	12.5		98		7
13	5 - 4	Nicollet Ave	18.4		94		22
14	5 - 5	Nicollet Ave	3.3		84		10
15	6 - 1	Portland Ave	11.4		83		15
16	6 - 2	Portland Ave	10.4		82		10
17	6 - 3	Portland Ave	22.7		98		7
18	7 - 1	12th Ave	10.6		82		10
19	7 - 2	12th Ave	7.2		82		10
20	7 - 3	12th Ave	15.7		98		7
21	8 - 1	TH 77	55.9		82		36
22	8 - 2	TH 77	8.5		80		27
23	8 - 3	TH 77	6.8		75		40
24	8 - 4	TH 77	9.2		82		18
25	8 - 5	TH 77	13.4		98		7
26	9 - 1	24th Ave.	6.7	7.1	87		22
27	9 - 2	24th Ave.	8.3	8.7	98		7
28	9 - 3	24th Ave.	6.5	6.8	84		28
29	9 - 4	24th Ave.	13.2	10.2	84		48
30	9 - 5	24th Ave.	10.3	5.7	91		33
31	Pk-n-Go	Park N Go	11.2		98		30
32	10 - 1	Int. Drive	13.7		77		33
33	10 - 2	Int. Drive	12.9	11.6	98		7
34	10 - 3	Int. Drive	16.0	3.4	91		12
35	10 - 4	Int. Drive	19.0	14.0	82	77	10
36	10 - 5	Int. Drive	4.3		89		15
37	Drop Str 1	VA Drainage	40.0	53.0	74		45

[1] Time of concentration and curve numbers were provided in the model. Complete calculations were not provided with the model or the TFS Report.

Total Drainage Area	450	437.6			
Avg. Area, CN (weighted), Tc	11.8	11.5	89	89	17

2 MODEL SIMULATION RESULTS

The Opt1_50yr.xp model provided by MnDOT was edited to incorporate the changes identified in Section 1.2 and renamed Opt1_BASE.xp. The model includes both the existing drainage system (pipes) under I-494, as well as the Tunnel Option 1 identified in the TFS. This model includes all of the corrected subwatersheds and can be used to model any of the scenarios of interest in completing the study. As adjusted, the model simulations were completed efficiently without computational difficulty.

2.1 Simulations of Existing Drainage System with Proposed Road Alignment

The tunnel was eliminated from the Opt1_BASE.xp model to simulate existing conditions. Simulations were made for the existing drainage system combined with the proposed roadway to evaluate existing drainage capacities. (The existing conditions simulations do not include the Penn Avenue drainage since there is no connecting pipe.) Table 2 shows the pipe diameters and inverts of the existing system.

Model results are presented for the 50-yr and 100-yr 24-hour storm events in Tables 3 and 4. The project 50-yr storm design criteria is no surcharging of the pipes, i.e. pressure head is less than the diameter of the pipe. The 100-yr storm requires no surface flooding at low points in the highway.

The existing conditions simulations (Tables 3 and 4)[2] demonstrate that there is inadequate capacity in the existing system to accommodate drainage from the proposed roadway. The 50-year simulation shows surcharging in most pipe segments, as well as surface flooding at several locations. The 100-year simulation produces surcharging and flooding at the same locations as for the 50-year.

The model indicates relatively small increases in the maximum discharge rate between the 50- and 100-year simulations. This is due to the surcharging and flooding (and backwater effects) which restrict discharge rates in the pipes, even though volumes and precipitation intensity is increased.

[2] **Pipe capacity** reported in Tables 3 and 4 represents the flowing-full capacity of each pipe given the size, slope, and friction coefficient, with no surcharging. **Maximum flow** represents the maximum simulated flow, which includes effects from surcharging and backwater. **No inflow** indicates a manhole or change in pipe where there is not a surface inlet.

Table 2. XP-SWMM Model Drainage System Characteristics - Proposed Road Alignment with Existing Drainage System.

Pipe Between	Pipe Size (in)	Upstream Invert Elev. (ft)	Downstream Invert Elev. (ft)
Colfax – Garfield Ave.	36	827.94	825.332
Garfield – Pleasant Ave.	36	825.12	821.63
Pleasant – Nicollet Ave.	54	820.08	816.18
Nicollet – Portland Ave.	54	816.2	805.12
Portland – Oakland Ave.	72	805.12	803.15
Oakland – 12th Ave.	84	803.15	801.68
12th Ave. – TH 77	84	801.68	799
TH 77 – 24th Ave.	84	799	794.665
24th Ave. –International Dr.	84	794.665	789.41
International Dr. - 34th Ave.	84	789.41	785.52
34th Ave. – MH 105	96	784.52	783.31
MH 105 – 107	96	783.31	781.29
MH 107 – 109	96	781.29	779.26
MH 109 – 111	96	779.26	777.46
MH 111 – Drop Structure	96	777.46	776.32
Drop Structure – Overflow Channel	96	760.9	760
Overflow Channel to Almaz Pond	54	755.38	748
Almaz Pond – Minnesota River	Channel	766.98	766
Overflow Channel	54	748	743.27
Park n' Go Connection	24	804.4	789.41

Table 3. XP-SWMM Results - Proposed Road Alignment with Existing Drainage System for 50-yr 24-hour design storm (5.3").

Pipe Between	Runoff Volume (ac-ft)	Cumulative Runoff Volume (ac-ft)	Pipe Capacity (cfs)	Max Flow (cfs)	Max d/D (depth/ diameter)	Surcharging	Surface Flooding
Colfax – Garfield Ave.	7.6	7.6	42	58	2.9	S	F
Garfield – Pleasant Ave.	6.1	14	37	55	2.3	S	F
Pleasant – Nicollet Ave.	10.7	24	108	123	2.1	S	F
Nicollet – Portland Ave.	15.3	40	121	142	2.1	S	F
Portland – Oakland Ave.	15.5	55	281	271	1.8	S	F
Oakland – 12th Ave.	No Inflow	55	177	254	1.6	S	
12th Ave. – TH 77	11.3	67	195	269	2.4	S	F
TH 77 – 24th Ave.	27.7	94	263	336	2.4	S	F
24th Ave. – International Dr.	13.0	107	302	410	3.0	S	F
International Dr. - 34th Ave.	13.9	121	329	582	3.0	S	
34th Ave. – MH 105	No Inflow	121	460	544	1.1	S	
MH 105 – 107	No Inflow	121	408	508	1.1	S	
MH 107 – 109	No Inflow	121	412	491	1.0	S	
MH 109 – 111	No Inflow	121	388	489	0.9		
MH 111 – Drop Structure	No Inflow	121	425	490	0.8		
Drop Structure – Overflow Channel	11.5	133	291	547	1.4	S	
Overflow Channel to Almaz Pond	No Inflow	133	433	400	3.8	S	
Almaz Pond – Minnesota River	No Inflow	133	1252	168	0.2		
Overflow Channel	No Inflow	133	347	273	0.7		
Park n' Go Connection	4.7	4.7	31	40	7.0	S	F

Table 4. XP-SWMM Results - Proposed Road Alignment with Existing Drainage System for 100-yr 24-hour Design Storm (5.9").

Pipe Between	Runoff Volume (ac-ft)	Cumulative Runoff Volume (ac-ft)	Pipe Capacity (cfs)	Max Flow (cfs)	Max d/D (depth/ diameter)	Surcharging	Surface Flooding
Colfax – Garfield Ave.	8.6	8.6	42	58	3.0	S	F
Garfield – Pleasant Ave.	6.9	16	37	55	2.3	S	F
Pleasant – Nicollet Ave.	12.0	27	108	121	2.1	S	F
Nicollet – Portland Ave.	17.3	45	121	140	2.1	S	F
Portland – Oakland Ave.	17.6	62	281	264	1.6	S	F
Oakland – 12th Ave.	No Inflow	62	177	252	1.5	S	
12th Ave. – TH 77	13.0	75	195	273	2.6	S	F
TH 77 – 24th Ave.	32.1	107	263	404	2.5	S	F
24th Ave. – International Dr.	14.9	122	302	418	3.0	S	F
International Dr. - 34th Ave.	16.1	138	329	589	3.0	S	
34th Ave. – MH 105	No Inflow	138	460	578	1.5	S	
MH 105 – 107	No Inflow	138	408	553	1.4	S	
MH 107 – 109	No Inflow	138	412	540	1.2	S	
MH 109 – 111	No Inflow	138	388	533	1.1	S	
MH 111 – Drop Structure	No Inflow	138	425	530	0.9		
Drop Structure – Overflow Channel	13.7	152	291	589	1.6	S	
Overflow Channel to Almaz Pond	No Inflow	152	433	400	3.8	S	
Almaz Pond – Minnesota River	No Inflow	152	1252	218	0.3		
Overflow Channel	No Inflow	152	347	277	0.7		
Park n' Go Connection	5.3	5.3	31	31	8.4	S	F

Model results confirm that the existing system in under capacity to handle proposed drainage conditions. Improvements to the existing system will be required to limit surcharging and flooding conditions.

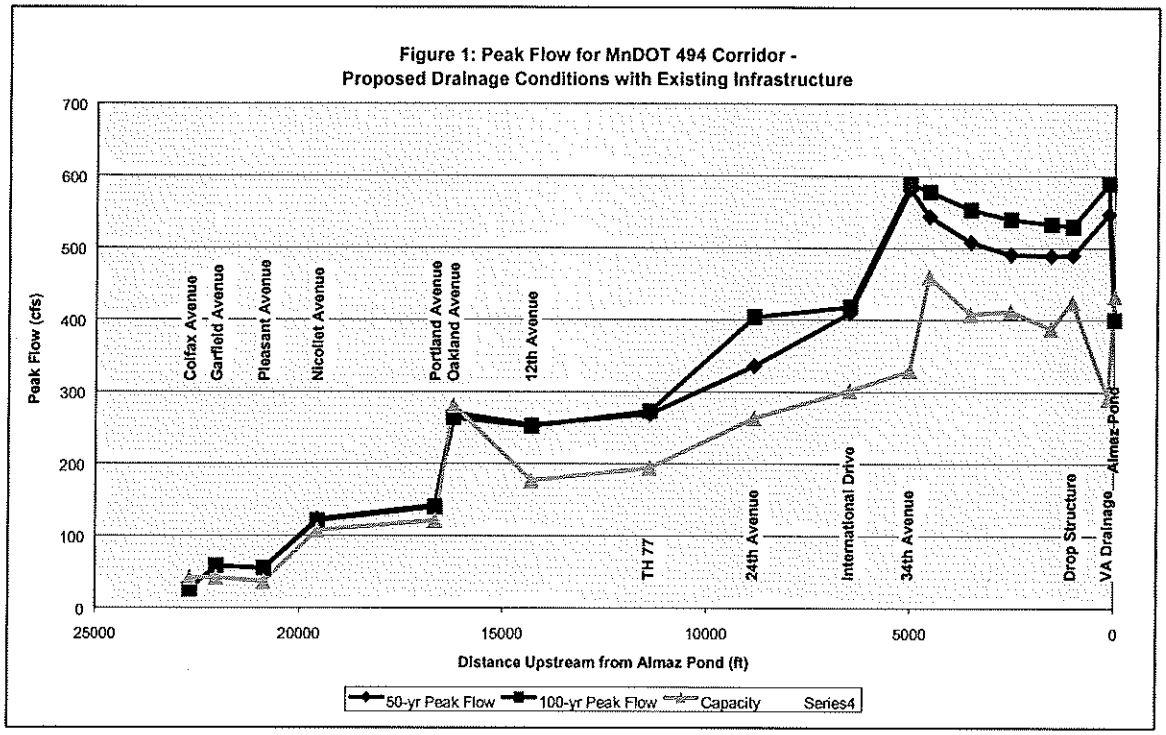


Figure 1 shows a profile of peak flow from upstream to downstream for the proposed roadway and existing drainage system. In the cases of both the 50- and 100-year discharges, discharge rates are limited by the capacity of pipes and the fact that surface flooding occurs at several locaitons. The model keeps track of the flooded volume, but does not model the storage depth that occurs at flooded locations. Therefore, while the model is currently not set up to determine flooded depth, it can be used to determine the excess volume at each flooded location. The model allows the flooded volume to discharge back to the pipe when capacity is available. Because flooding is not allowed under the design scenarios, this approach to flooding is adequate. If additional conveyance were provided to eliminate surcharging and surface flooding, maximum flow rates would increase over those reported in Tables 3 and 4.

2.2 Spatial Extent of Existing System Capacity.

A separate analysis was undertaken to determined how much of the corridor – starting in the East – could be drained using just the existing trunk sewer pipes and Almaz Pond. (The remaining area would be drained in separate pipe or tunnel, either parallel to the existing system or draining to the South.) Capacity was evaluated incrementally upstream from Almaz Pond by adding one subwatershed at a time, moving west until the existing pipe reached capacity. Surcharging and flooding criteria were only reported along the corridor drainage system. The Park n' Go connection surcharged and flooded under all scenarios. Since the flooding does not affect the highway, it was not used as a design criteria. Table 5 demonstrates the results of the modeling.

Table 5: Upstream Incremental Results from Almaz Pond for MnDOT I-494 Drainage

U/S Limit (Moving from Almaz Pond US)	50-yr Surcharge[3]	100-yr Flooding	50-yr Cumulative Runoff Volume (ac-ft)	50-yr Peak Flow at outlet to Almaz Pond (cfs)	100-yr Peak Flow at outlet to Almaz Pond (cfs)
Drop Structure/VA Drainage			11.5	89	106
International Dr.			25.4	222	256
International Dr.			30.1	249	288
24th Ave.			43.1	332	380
TH 77	S (d/D ~1.1)		70.8	476	540
12th Ave	S	F	82.1	531	603

The above results demonstrate that the existing system can be utilized to drain the corridor from 24th Avenue low point (and the high point at Sta. 748+60) downstream to Almaz Pond without expansion of the system. (Model results upstream of 12th Avenue are not reported because surcharging and flooding occurred in the system.)

When the TH 77 interchange is added, no flooding occurs, but minor surcharging of the system occurs. Accepting minor surcharging would extend the usefulness of the existing system. Alternatively, the portions of the TH 77 drained to the East could be reduced.

These results are of interest in planning the various tunnel alignments which would not have to serve areas East of, and including, the TH 77 corridor.

A similar analysis was attempted for the upstream end of the system, however, the pipes upstream of Portland Avenue are undersized.

[3] The drop structure connection at the VA inlet to system would surcharge due to backwater effects from the Almaz pond; this was not considered as surcharging for this analysis.

2.3 Estimate of Live Storage Volume

Proposed drainage conditions were modeled to determine runoff and flooded volumes for each segment of the corridor. (Since there is no existing connection of the Penn Avenue drainage to the existing system, Penn Avenue was evaluated based on hydrologic properties given in SRF Model Opt1_50 yr.xp. Note that the 35W interchange is not in the model as it drains to Upper Penn Lake. The Penn Avenue drainage therefore would cross the 35W corridor.)

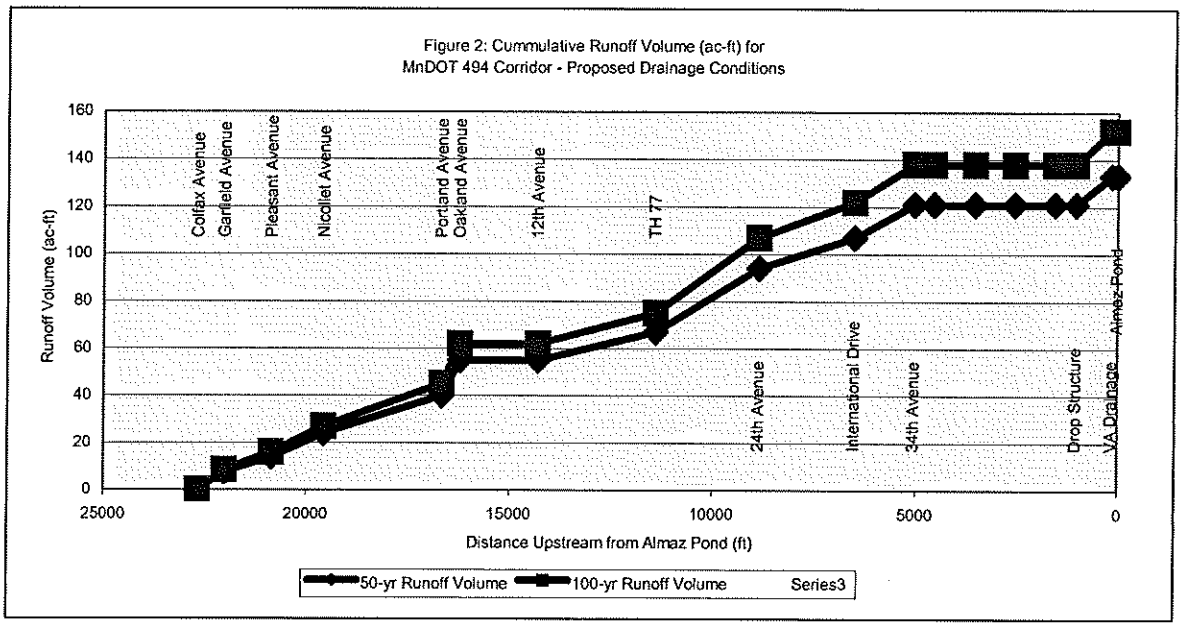
Flooded volumes for each low point are tabulated in Table 6 as an approximation of the live storage required to alleviate flooding at each location. Detailed models are required to locate and size storage facilities.

Table 6: XP-SWMM Runoff Volumes

Collection Point/Low Point	50-yr Design Storm		100-yr Design Storm		Flooded Volume	
	Runoff Volume (ac-ft)	Cumulative Volume (ac-ft)	Runoff Volume (ac-ft)	Cumulative Volume (ac-ft)	50-yr (ac-ft)	100-yr (ac-ft)
Penn Ave.	6.1	6.1	6.9	6.9	0.0[3]	0.0[3]
Colfax Ave.	7.6	13.7	8.6	15.5	1.0	1.3
Garfield Ave.	6.1	19.8	6.9	22.4	3.7	4.3
Pleasant Ave.	10.7	30.5	12.0	34.3	3.7	4.3
Nicollet Ave.	15.3	45.8	17.3	51.6	2.6	3.3
Portland Ave.	15.5	61.3	17.6	69.2	1.3	1.9
12th Ave.	11.3	72.6	13.0	82.2	16.5	24.7
TH 77	27.7	100.3	32.1	114.3	0.1	0.2
24th Ave.	13.0	113.4	14.9	129.2	0.2	0.2
International Dr.	13.9	127.3	16.1	145.3	0.0	0.0
VA Drainage	11.5	138.8	13.7	159.0	0.0	0.0
W/Park n' Go Connection	4.7	143.5	5.3	164.3	0.1	0.2
Total	143.5		164.3		29.2	40.6

[3] Based on TFS Option 1 model provided by SRF.

Figure 2 provides a representation of runoff volumes from Table 6 versus distance along the corridor upstream from Almaz Pond. Almaz Pond has 41 ac-ft of live storage below the overflow elevation of 766.8. In the 100-year simulation, the pond storage increase is 30 ac-ft, increasing the pond elevation from El. 760 to El. 765.1.



2.4 Water Quality Detention Volume Requirements

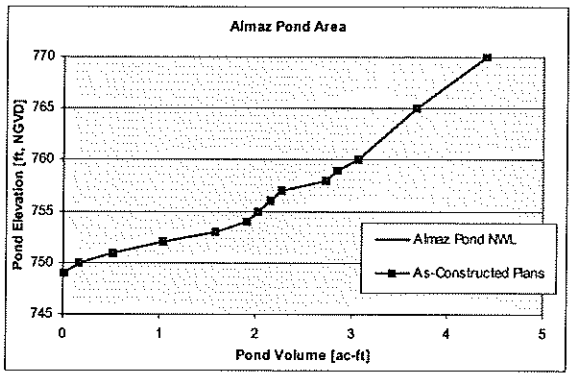
Requirements for water quality detention (dead volume) were estimated using the runoff volumes from the 1-year (2.5 inch) design storm. Results for each collection point are provided in Table 7.

Table 7: Water Quality Runoff Volume Requirements

Collection Point/Low Point	2.5-inch (1-yr) Volume (ac-ft)
Penn Ave.	2.7
Colfax Ave.	3.1
Garfield Ave.	2.6
Pleasant Ave.	4.7
Nicollet Ave.	6.0
Portland Ave.	5.7
12th Ave.	4.1
TH 77	8.8
24th Ave.	4.9
International Dr.	4.4
VA Drainage	2.7
Park n' Go Connection	2.1
Total	51.7

2.5 Almaz Pond Volume

The existing dead storage (water quality) volume of the Almaz Pond, as determined from as-constructed drawings, is 19 acre-feet at El. 760. (The volume determined from the area-stage information in the XP-SWMM model was 52 acre-feet. The pond areas have been corrected in the model.) The pond area and volume are shown below:



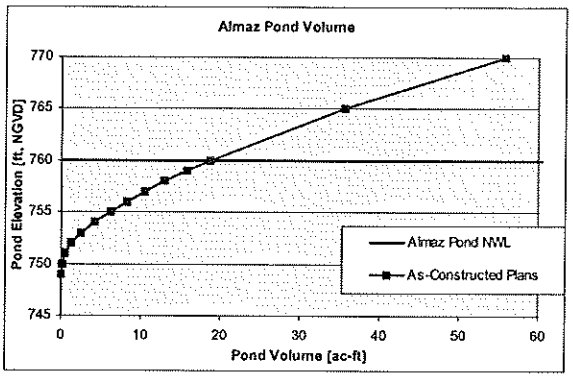


Table 1
I-494 Drainage Feasibility Study
Bloomington, Minnesota

Piezometer Number P-1	Location Penn Av.	Ground Surface Elevation 826.1	Top of Riser Elevation 828.17
Date	Approx. Time	Depth to Water	Water Elevation
9/16/2004	13:00	16.92	811.25
10/7/2004	12:00	16.94	811.23
11/11/2004	12:00	16.95	811.22
1/4/2005	12:30	16.93	811.24
2/16/2005	11:00	16.96	811.21
3/11/2005	10:00	16.91	811.26
9/18/2006	11:20	NR	NR
10/6/2006	14:00	NR	NR
11/17/2006	15:25	NR	NR
1/15/2007	12:30	NR	NR
2/15/2007	14:00	NR	NR

Piezometer Number P-2	Location Nicollet	Ground Surface Elevation 826.6	Top of Riser Elevation 829.78
Date	Approx. Time	Depth to Water	Water Elevation
9/16/2004	13:00	17.91	811.87
10/7/2004	12:00	18.01	811.77
11/11/2004	12:15	18.15	811.63
1/4/2005	12:45	18.4	811.38
2/16/2005	11:10	18.55	811.23
3/11/2005	10:10	18.64	811.14
9/18/2006	11:35	17.94	811.84
10/6/2006	14:10	17.99	811.79
11/17/2006	15:35	18.19	811.59
1/15/2007	12:40	18.46	811.32
2/15/2007	14:30	18.61	811.17

Piezometer Number P-3	Location Portland	Ground Surface Elevation 825.3	Top of Riser Elevation 828.22
Date	Approx. Time	Depth to Water	Water Elevation
9/16/2004	13:25	17.79	810.43
10/7/2004	12:00	17.8	810.42
11/11/2004	12:30	17.93	810.29
1/4/2005	13:00	18.15	810.07
2/16/2005	11:25	18.35	809.87
3/11/2005	10:25	18.41	809.81
9/18/2006	11:45	17.74	810.48
10/6/2006	14:40	17.79	810.43
11/17/2006	15:20	18.00	810.22
1/15/2007	12:45	18.26	809.96
2/15/2007	14:38	18.43	809.79

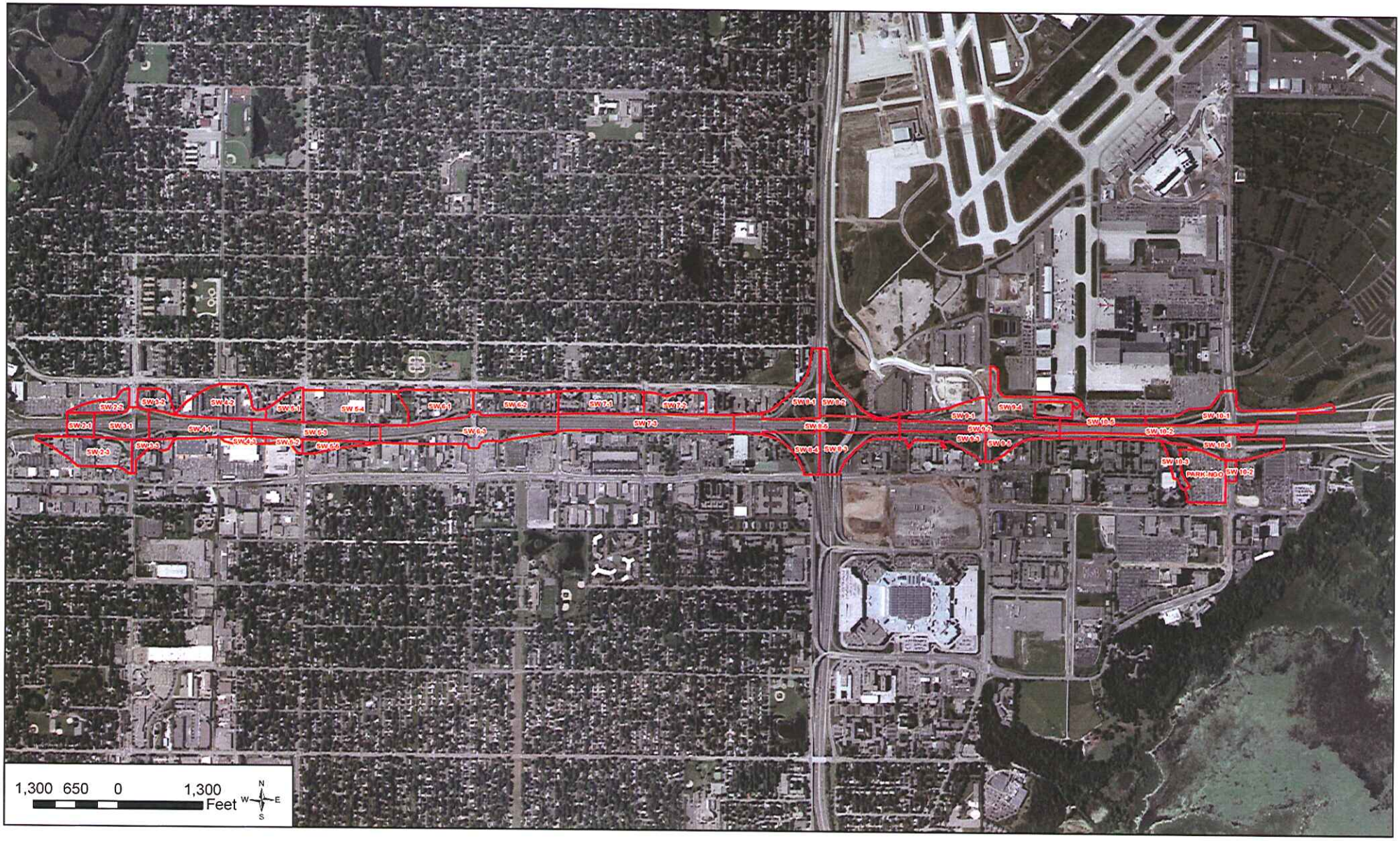
Piezometer Number P-4	Location T.H. 77	Ground Surface Elevation 826.9	Top of Riser Elevation 830.9
Date	Approx. Time	Depth to Water	Water Elevation
9/16/2004	13:40	26.03	804.87
10/7/2004	12:00	26.05	804.85
11/11/2004	12:45	26.15	804.75
1/4/2005	13:15	26.26	804.64
2/16/2005	11:40	26.43	804.47
3/11/2005	10:40	26.45	804.45
9/18/2006	12:00	26.14	804.76
10/6/2006	14:30	26.19	804.71
11/17/2006	15:55	26.37	804.53
1/15/2007	12:50	26.55	804.35
2/15/2007	14:43	26.66	804.24

Piezometer Number P-5	Location West Pond	Ground Surface Elevation 716.0	Top of Riser Elevation 718.46
Date	Approx. Time	Depth to Water	Water Elevation
9/16/2004	13:50	15.44	703.02
10/7/2004	12:00	15.52	702.94
11/11/2004	13:00	15.23	703.23
1/4/2005	13:30	15.57	702.89
2/16/2005	12:00	15.58	702.88
3/11/2005	11:00	15.41	703.05
9/18/2006	10:25	15.72	702.74
10/6/2006	13:00	15.94	702.52
11/17/2006	15:05	17.61	700.85
1/15/2007	13:20	15.55	702.91
1/15/2007	15:30	15.42	703.04

Notes:

9-18-06: P-1 has been destroyed, no data collected

10-6-06: Took photos of P-1


SW 2-2
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SW 4-2
SW 5-1
SW 5-4
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SW 7-1
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MINNESOTA DEPARTMENT OF TRANSPORTATION
Engineering Services Division
Technical Memorandum No. 06-26-B-02
August 8, 2006

TO: Distribution 57, 612, 618, and 650

FROM: Richard Stehr
Division Director
Engineering Services

SUBJECT: Storm Drain Design Frequency and Catch Basin Spacing

Expiration
This Technical Memorandum supersedes Technical Memorandum 03-01-B-01 and will expire on August 8, 2011 unless superseded or placed into the Mn/DOT Drainage Manual prior to that date.

Implementation
The provisions of this Technical Memorandum have been in effect, and should continue to be incorporated into the design of trunk highway storm drain systems.

Introduction
Storm drain design frequency and catch basin spacing criteria are used in the design of storm drain systems. Questions regarding interpretation of policy provided in the August 2000 edition of the Mn/DOT Drainage Manual are intended to be addressed by this Technical Memorandum.

Purpose
This Technical Memorandum is intended to clarify policy relating to design frequency and spacing of catch basins for storm drain systems contained in the August 2000 edition of the Mn/DOT Drainage Manual.

Guidelines
The design frequency for storm drains and the allowable spread of water onto the roadway shall be in accordance with the following criteria:

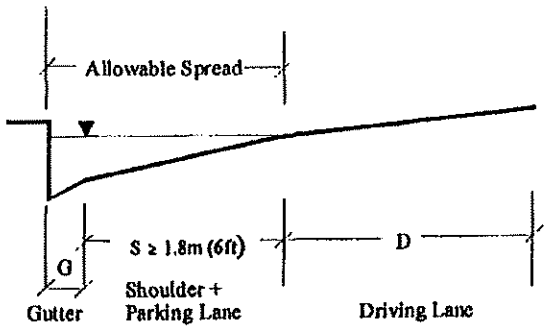
TRUNK HIGHWAY MAINLINE
DESIGN FREQUENCY FOR STORM DRAINS

PROJECTED 2-WAY ADT (vehicles/day)	DESIGN FREQUENCY	DESIGN SPEED	ALLOWABLE SPREAD [1]
5000 and Greater	10 Year 10 Year 50 Year at Sag Point [2]	> 60 km/h **(40 mph)** ≤ 60 km/h **(40 mph)**	P, S, or 1/3 D P, S, or 1/2 D P, S, and 1/2 D
1000 to 4,999	5 Year 5 Year	> 60 km/h **(40 mph)** ≤ 60 km/h **(40 mph)**	P, S, or 1/3 D P, S, or 1/2 D
0 to 999	3 Year 3 Year	> 60 km/h **(40 mph)** ≤ 60 km/h **(40 mph)**	P, S, or 1/3 D P, S, or 1/2 D

[1] P = Parking lane, S = Shoulder of 1.8 m **(6 ft)** or greater, D = Driving lane
[2] Sag Point refers to a true sag where flooding of 0.6 m **(2 ft)** or more can occur.

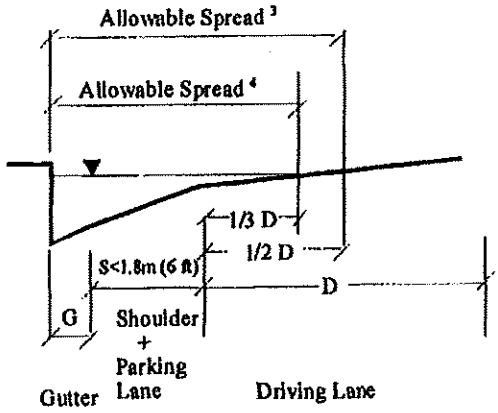
- MORE -

No Spread Allowed on Driving Lane
Allowable spread when shoulder width is equal to or greater than 1.8 m **(6 ft).**



Spread Allowed on Driving Lane
Allowable spread when the sum of the shoulder and the parking lane is less than 1.8 m **(6 ft).**

[3] For Design Speed ≤ 60 km/h **(40 mph)**
[4] For Design Speed > 60 km/h **(40 mph)**



Trunk Highway Turn Lanes
Design Frequency –Same as for mainline
Allowable Spread – 1/2 lane width

Trunk Highway Ramps and Loops
Design Frequency – Same as for mainline
Allowable Spread – 1/2 roadway width

Interstate Highway Mainline
Design Frequency –10-year for catch basins on grade
50-year at sag point
Allowable Spread – Shoulder

Ramps and loops associated with Interstate Highways should be designed for a 10-year storm using the above criteria for allowable spread.

Sag points on Interstate Highway mainline shall be designed so that the spread is limited to the shoulder for the 50-year storm. Storm drains outletting from Interstate Highway mainline low points shall be designed for the 50-year storm.

- MORE -

Frontage Roads
Design Frequency and Allowable Spread – Use criteria as shown in State Aid Manual 5-892.600.

Local Streets
Design Frequency and Allowable Spread – Use criteria as shown in State Aid Manual 5-892.600 if the road is on State Aid System; otherwise use criteria established by the local road authority.

Sag Points
At sag points it is recommended that curb inlets or combination grate/curb openings be utilized. If a grate alone is used at sag point, consideration should be given to assuming a portion of the grate to be clogged by debris. A reasonable assumption is to assume that the grate is half clogged with debris.

For sag points on trunk highways with ADT < 5000 vehicles per day, and for all local roads, consideration should be given to designing sag points at critical locations for a higher frequency in order to limit water ponding to a depth less than 0.6 m **(2 ft)** on roads that are otherwise passable.

Questions
Any questions regarding the contents of this Technical Memorandum should be referred to **Andrea Hendrickson, State Hydraulics Engineer, Bridge Office at (651) 747-2161.**
Any questions regarding the publication and distribution of this Technical Memorandum should be referred to Sophia Wicklund, Design Standards Unit at 651-296-3190, or Michael Elle, Design Standards Engineer at 651-296-4859. All active Memoranda and a list of historical Technical Memoranda can be viewed at http://www.dot.state.mn.us/tecsup/tmemo/index.html.

- END -

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

TECHNICAL MEMORANDUM

TO: Alan Palmer, P.E., Stanley Consultants

FROM: Chris Meehan, PE and John Thene, PE

DATE: August 29, 2006

SUBJECT: I-494 Existing System Rate Control Calculations

Below is the requested information regarding XPSWMM stormwater models created as part of the Interstate 494 (I-494) improvement project. This information is requested to assist MnDOT in determining rate control requirements of the I-494 outfall to the Minnesota River. Peak flow rates were determined for three previously-modeled scenarios: the existing system, the tunnel Option 1A and the tunnel Option 1C. Option 1A is the 9.0-ft tunnel system as designed in the SRF study; Option 1C is the 10-ft tunnel option as in the Stanley study.

Peak flow rates and associated hydrographs were totaled for each outlet to the Minnesota River for Lower Minnesota River Watershed District (LMRWD) rate control requirements. Peak flow rates were determined at three separate points: the existing system bypass to West Pond area prior to Almaz Pond; the Almaz Pond outlet; and for Options 1A and Option 1C at the tunnel outlet prior to any ponding.

A table of peak discharge rates is provided below. The results confirm that the construction of the 10-foot tunnel in Option 1C would provide the highest peak rate for each of the three alternatives. Option 1C represents the peak runoff rate with minimal storage effects. The Option 1C results are in contrast to the existing system result where water is stored in flooded areas and most of the discharge is forced through Almaz Pond; the peak discharge from the pond is limited by the capacity of its outfall and the existing system.

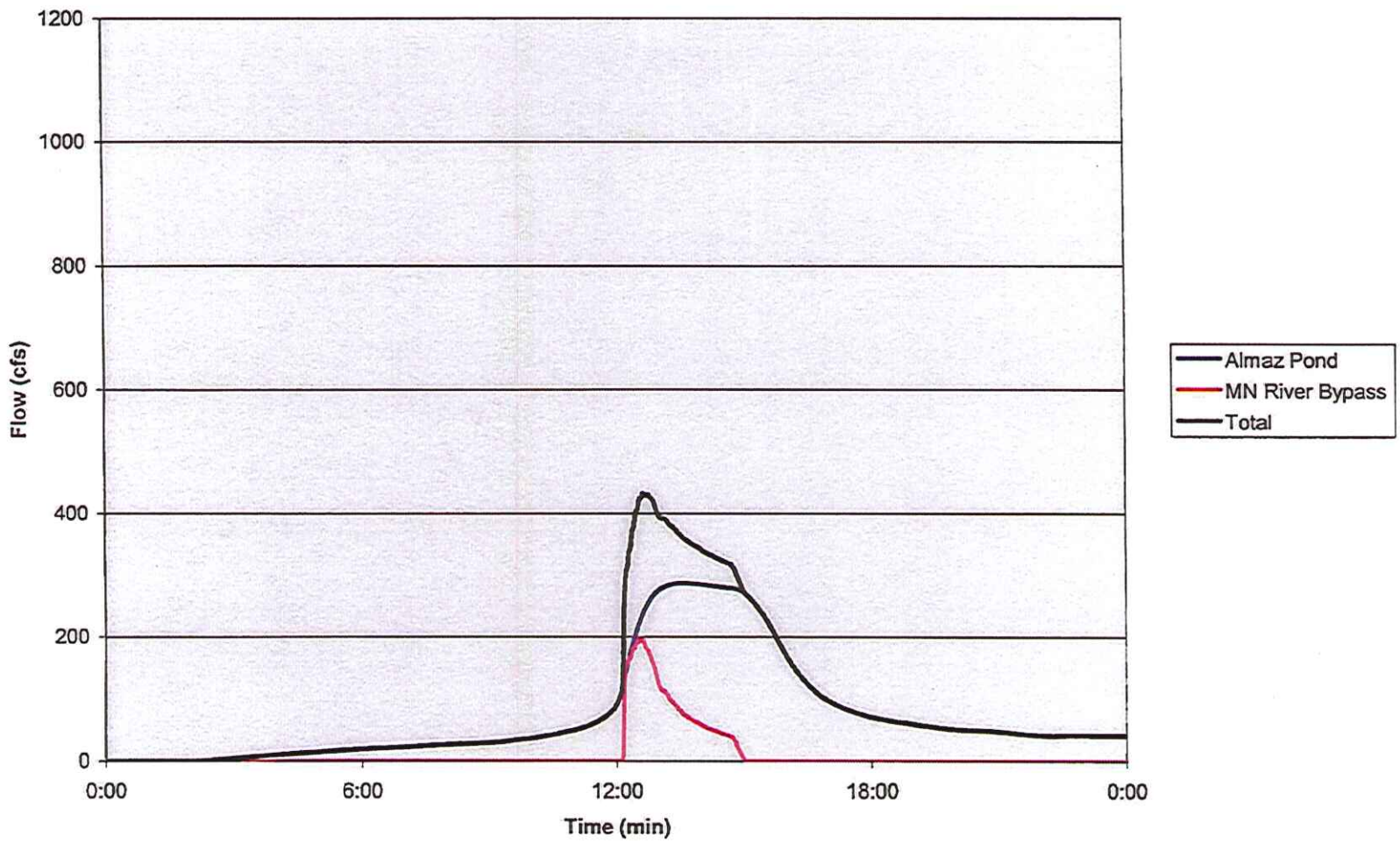
MnDOT should use the Option 1C peak to approach the LMRWD and seek approval to discharge without additional storage requirements. Inspection of the storm hydrographs indicates that even with the storage afforded by the flooding (limiting the peak runoff to 467 cfs) the majority of the runoff will reach the Minnesota River between hours 12:00 and 17:00. With no restriction in flow (Option 1C) the majority of the volume will reach the river between hours 12:00 and 16:00. For the Minnesota River, detaining this volume of water for such a short time, it is unlikely to result in a tangible benefit in terms of river stages. Detaining the water may tend to add to peak river discharges from upstream.

Attached are peak hydrographs for each of the alternatives demonstrating the hydrographs for each outlet point and also a compiled total hydrograph for each scenario. Peak discharge rates are summarized below:

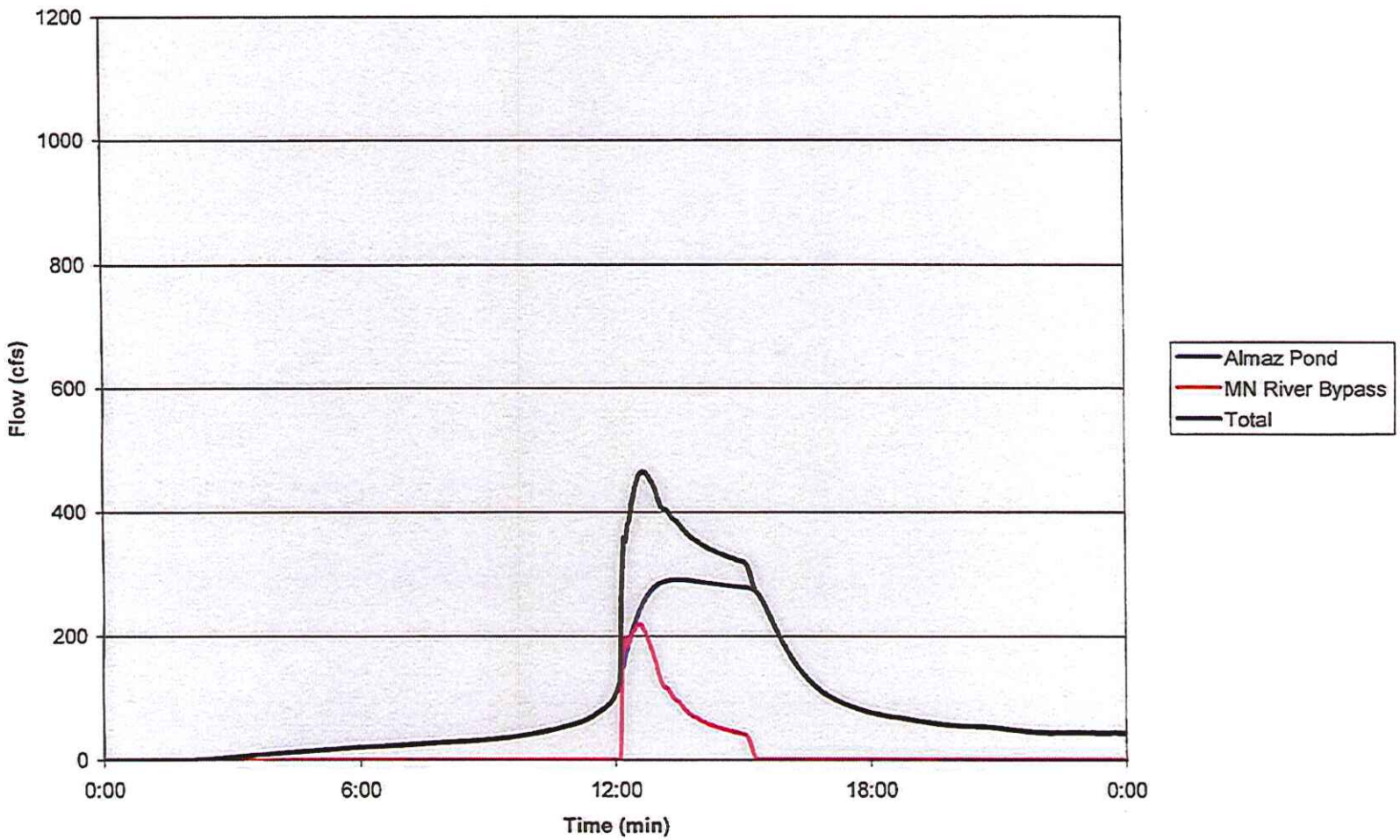
50-Yr Event	Merged Hydrograph Peak (cfs)	Almaz Pond L-249 Peak Flow (cfs)	Almaz Bypass L-310 Peak Flow (cfs)	Tunnel L-310 Peak Flows (cfs)
Existing System	433	287	197	N/A
Option 1A	753	209	131	492
Option 1C	984	233	101	706

100-Yr Event	Merged Hydrograph Peak (cfs)	Almaz Pond L-249 Peak Flow (cfs)	Almaz Bypass L-310 Peak Flow (cfs)	Tunnel L-310 Peak Flows (cfs)
Existing System	467	293	224	N/A
Option 1A	818	224	186	518
Option 1C	1138	248	150	802

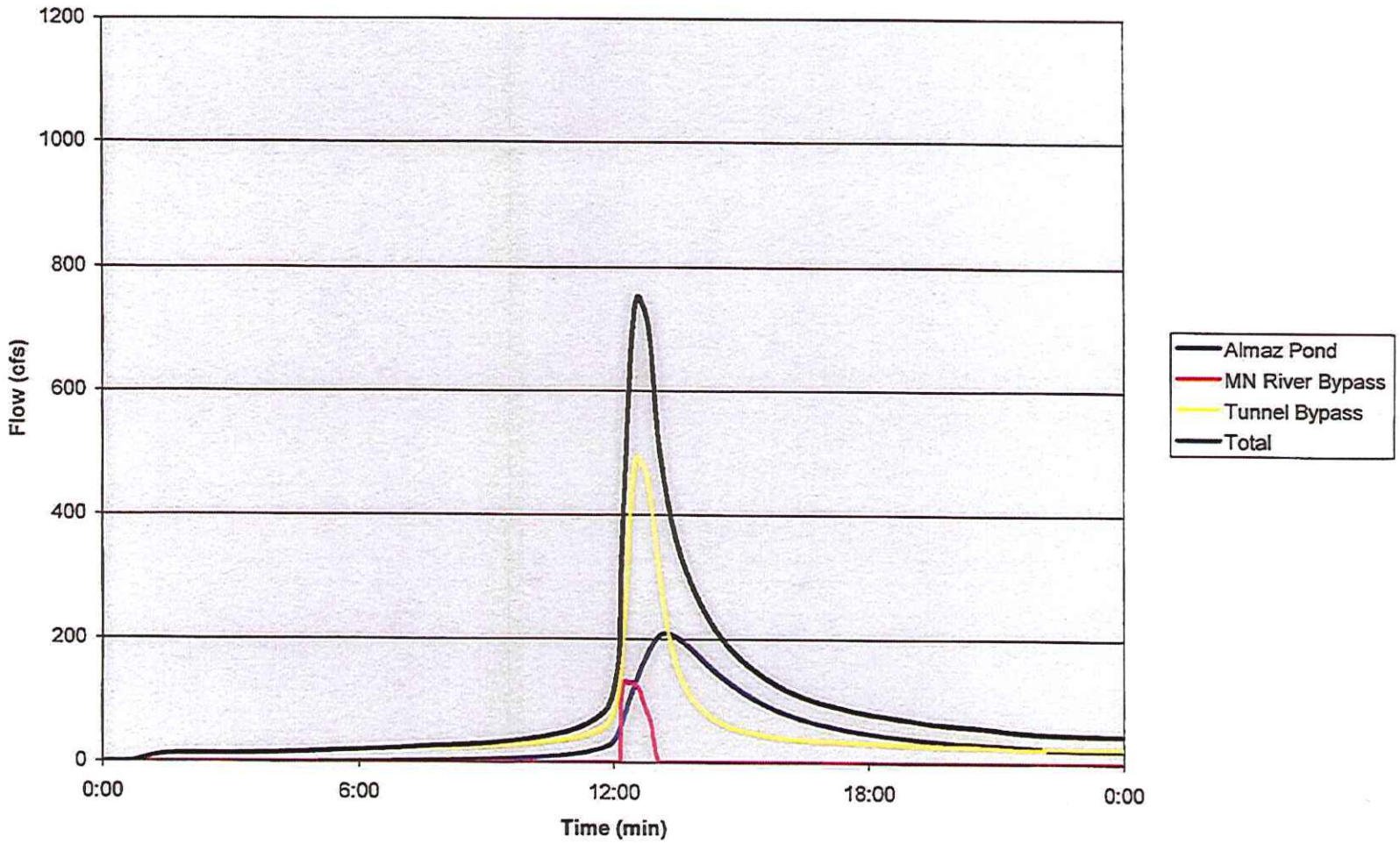
Existing 50-Year Event XP-SWMM Output Hydrographs



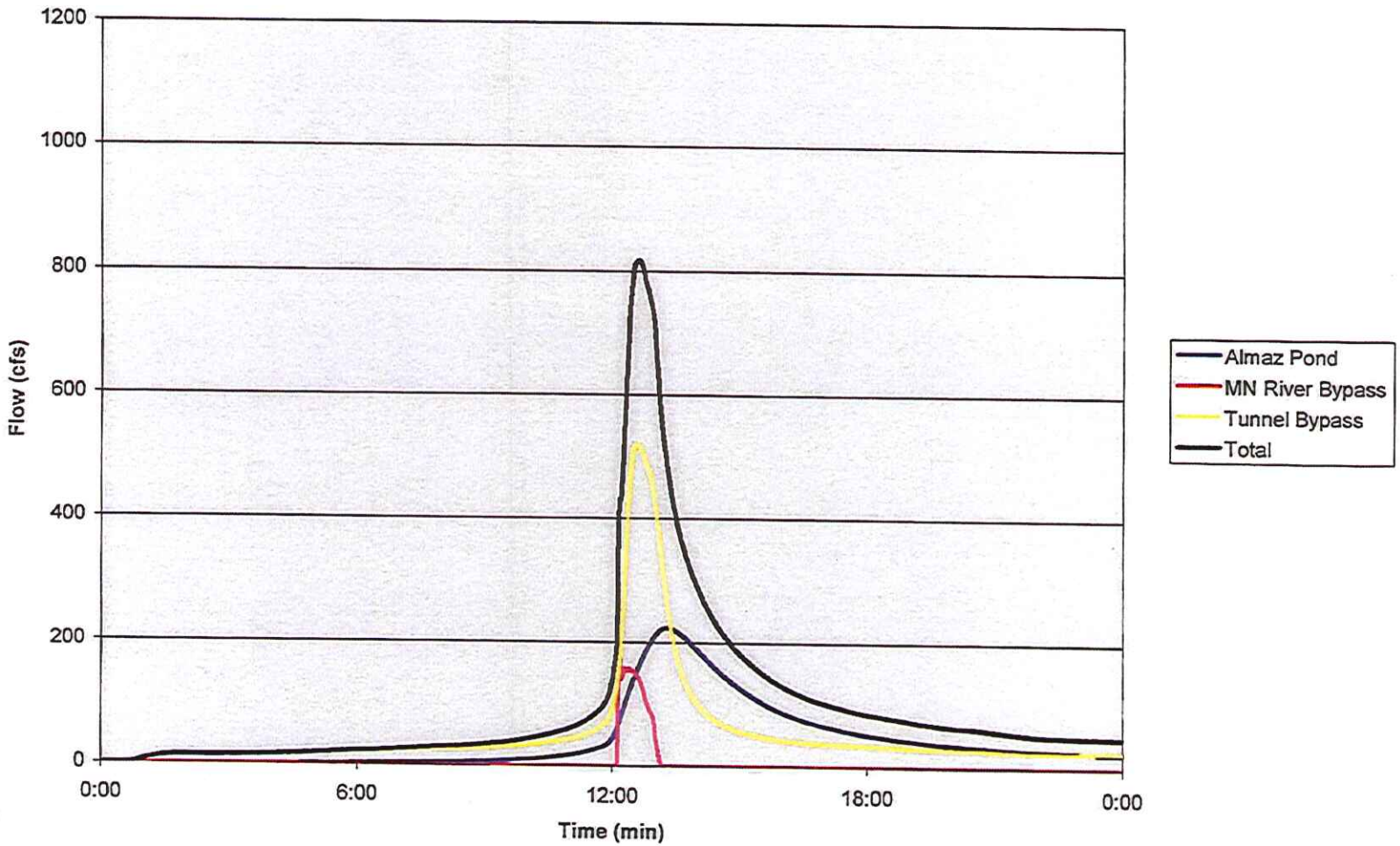
Existing 100-Year Event XP-SWMM Output Hydrographs



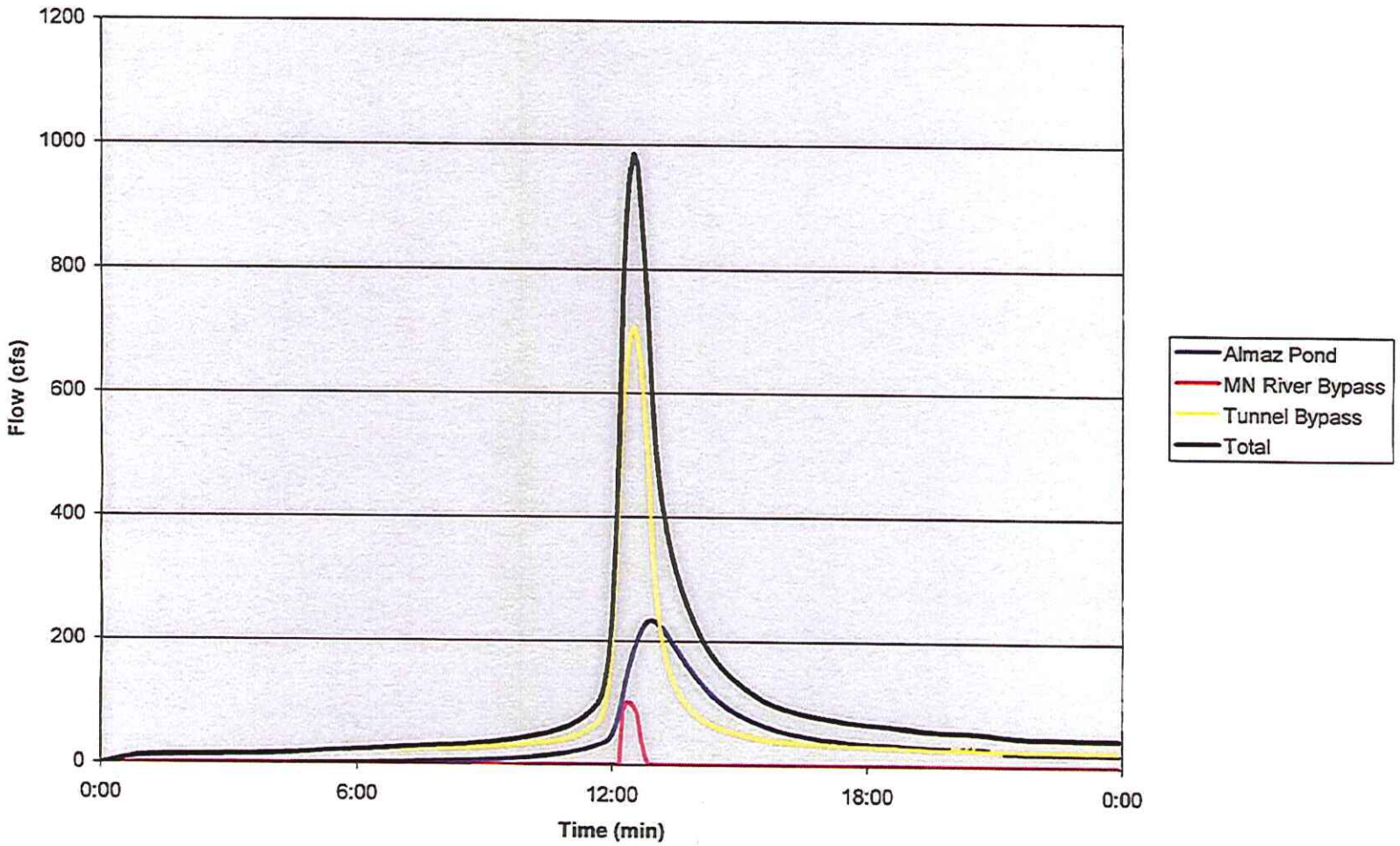
Option 1A 50-year Event XP-SWMM Output Hydrographs



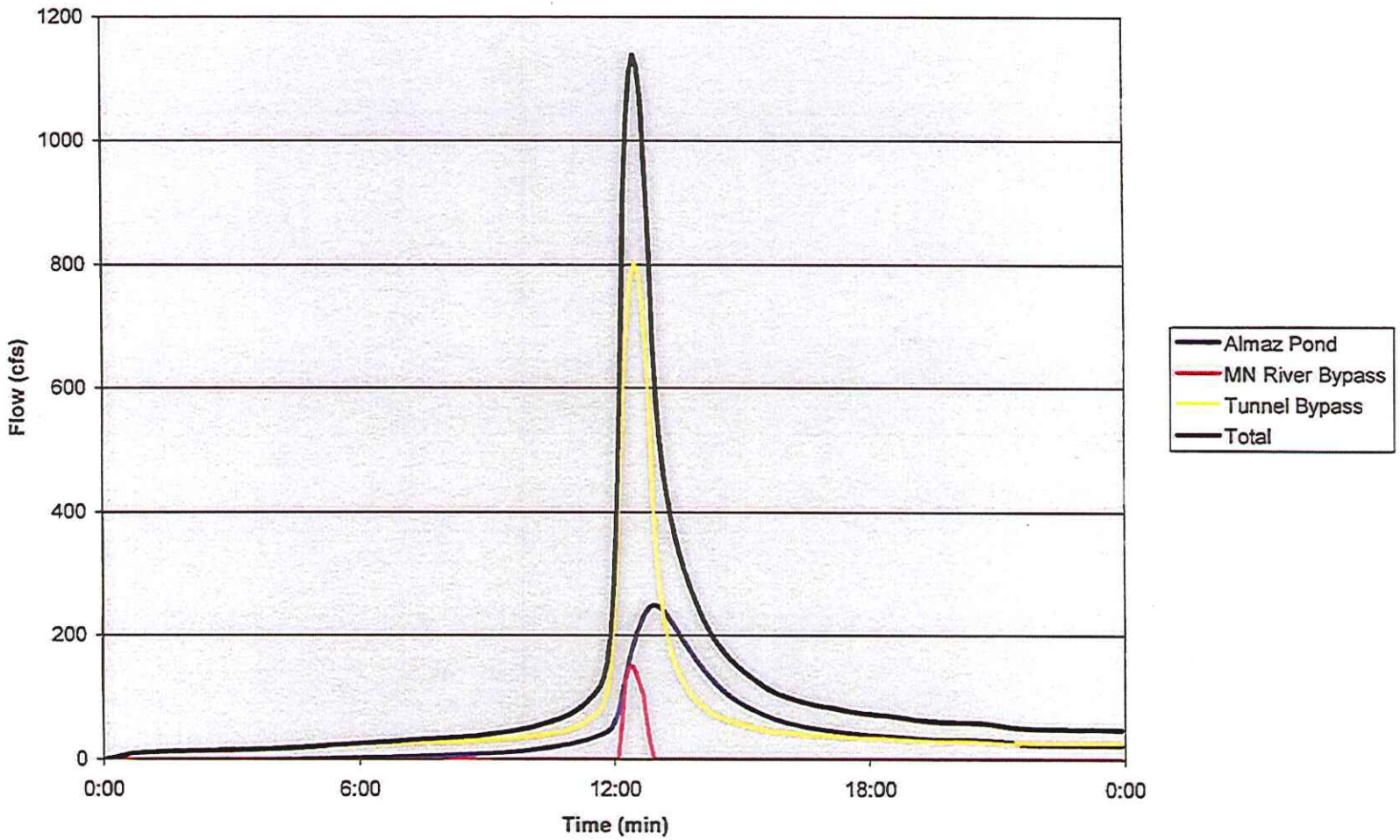
Option 1A 100-year Event XP-SWMM Output Hydrographs



Option 1C 50-year Event XP-SWMM Output Hydrographs



Option 1C 100-year Event XP-SWMM Output Hydrographs



Stanley Consultants INC.

TELEPHONE CALL REPORT

Date:	September 6, 2006	**Time:** 1300	**Project No.:** 19636.01.00
To:	Alan Palmer	**Representing:**	Stanley Consultants, Inc.
Location:	Minneapolis, MN	**Phone No.:**	1.952.797.5387
From:	Dan Ghere	**Representing:**	FHWA - Hydraulics
Location:	Chicago, IL	**Phone No.:**	1.708.283.3557
Subject:	I-494 Stormwater Alternatives - Buried storage		

I had spoken with Dan on 03 August about the I-494 project, specifically in regards to the use of underground storage cells to provide detention storage. I explained that the current underground storage concept was to bury large series of 14W x 10H RCBC's immediately beneath the proposed Interstate highway at each sag. These storage cells would be sized to detain the flow as necessary so that we could reutilize the existing storm sewer system.

My question to Dan at that time was if the FHWA had any experience with this sort of installation under the Interstate Highway System. He responded than that he knew of no such installation, but would ask his colleagues from across the country while attending an upcoming FHWA conference.

When Dan called on 06 September he reported that although his colleagues were familiar with similar detention storage systems, their use had been limited to parking lots and other low load conditions, and that there were no installations of this type under major Federally funded highways that he or his peers could recall.

As expected, there were concerns regarding removal of silt deposits. However, Dan agreed that the basic technology was mature. After all, this would be merely a multiple celled box culvert, similar to tens of thousands of other installations. The only real constructed difference was that these would be installed longitudinally and would require distribution/collection manifolds at each end. He further agreed that the hydraulics were straight forward and that the storage system would likely perform as expected.

In addition, Dan suggested that the culverts be specified to resist corrosion, and that any life cycle cost analysis consider the work required to remove and replace the box culvert sections, or to rehabilitate them as required.

Stanley Consultants INC.

MEETING NOTES

No. 001

Date: 06 September 2006

Place: City of Bloomington

Project/Purpose: I-494 Stormwater Alternatives

Attendees:
Scott Anderson, City of Bloomington
Charles Honchell, City of Bloomington
Shelly Pederson, City of Bloomington
Beth Neuendorf, Mn/DOT
Julie Whitcher, Mn/DOT
John Thene, Wenck Associates, Inc.
Alan Palmer, Stanley Consultants, Inc.
Jessica Willey, Stanley Consultants, Inc.

Notes By: Jessica Willey

The following meeting notes set forth our understanding of the discussions and decisions made at this meeting. If you have any questions, additions, or comments, please contact the writer immediately. If we do not hear from you, we will assume that our understandings are the same. We are proceeding based on the contents of these meeting notes.

This purpose of this meeting was to document reactions from the City of Bloomington regarding the I-494 Stormwater Alternatives.

Stanley handed out a power point presentation along with a set of plans and profiles for the project which included: introductions, analysis objectives, analysis preliminaries, hydraulic model and drainage alternatives. Stanley went over most of this presentation with Wenck discussing the hydraulics portion. Highlights included: narrowing the alternatives down to six, standards used for the hydraulic model, plans showing the existing system (store over 40 ac-ft for the 100-year event) and 10% of the drainage coming from Bloomington.

Tunnel Advantages
The pumps at Penn would not be needed.

Almaz is a state pond that I-494 can drain into.

Locally, it is much easier to agree with this option.

Bloomington felt that since Mn/DOT is already spending so much money on this project, it would be worth it to spend a little more money and not have to deal with all the hassle to get the land, versus going with the cheaper option of the surface ponds, and having to acquire all the land.

Tunnel Disadvantages
A tunnel with no ponding until the end of I-494 by the river would be very expensive.

Based on existing cost figures, it would cost $20 mil more than using the existing system with surface ponds.

The City's experience with underground storage "pipes" is limited, but they have seen some sites with both open

and closed bottoms. Maintenance (how effective and cost) is still unknown. Water volume is an issue, as well as how to get the sludge out and capture the silt or minimize it from getting into the structures. It is difficult to get people into the storm detention structures, so the City has not had great luck maintaining them. They are currently working with CDS in designing better structures.

I-494 will be built either eastbound or westbound with alignment in the ROW mainly under the southside lanes. This is no concern for the City. Construction will be a smaller issue as part of the road will have to be shut down.

Ponds Advantages
At 24th and I-494 by the airport there is some green space that may be available. Above ponds may not work because of birds landing, but underground storage may be an option. This area will not be redeveloped.

Richfield has many older sites in need of redevelopment.

The City is in favor of I-494 expansion and having it drained.

Ponds Disadvantages
There would be a maintenance component to upstream sediment basins.

The economical value of losing Southtown Center (including jobs) must be considered. Homes are easier to lose than a shopping center with taxes, etc.

Per consultant, 90% of the ponds (except one) were located in Bloomington (when they only have 10% of the drainage) because there were more single owners there and it was thought it would be easier to get the land.

Per City of Bloomington, the price of land is very expensive by I-494 so it may not be as cheap as the tunnel.

Per City of Bloomington, the City will continue to build with no set plan. Six alternatives do not matter or stop anything from being built. If Mn/DOT were to pick one alternative of what to do, the City would help stop people from building in places that this alternative would go. But unless you know what to protect, you cannot protect it. No decisions can also be expensive, especially when the City has been building a lot in the area. The alternative that is chosen may no longer be doable in the future. It may become more of a non-project then.

Other Items
Bloomington uses a salt/sand combo on their roads.

For Bloomington, only flooding by Penn is a problem. Water goes directly to Nine Mile Creek (listed for turbidity) and may be listed as an impaired creek in the future.

Bloomington is subjected to non-degradation standards.

The life of the tunnel versus the life of the existing stormwater piping system was not analyzed, but will be in the future.

I-35W Option- Could Mn/DOT assist city with 35W and redirect drainage? Penn is a big problem. The pipe does not have the needed capacity. The City would be okay with a shared solution or share a pond that both Mn/DOT and the City can use. Bloomington may not have the time to wait and if the City uses up available space for ponds now, they may object if Mn/DOT tries to use them later. Mn/DOT has no money to help share the cost now. A payback may work with the City now. The City Council is pushing for drainage issues now and they do have some money available within the next few years. Protective buying may be an option. Will I-35W drain south to the river with a tunnel? Can I-494 be incorporated into I-35W? No, since the timeframe for I-35W is not on the 20 year plan for Mn/DOT it is even further out than I-494. Mn/DOT has not considered an I-35W shared drainage option that would carry I-35W and some of Bloomington's water. Bloomington may build ponds and sell some of them back to Mn/DOT later.

Timeline – The report is due by the end of the year and the City can be on the list to review it. There is no money now to design. The Stanley report will only include reactions of the various alternatives; Mn/DOT will make the final decision on an alternative.

The City can tell the Council that we all met and what we discussed and let them know a report will be coming out soon.

Distribution:

Beth Neuendorf, Mn/DOT
Julie Whitcher, Mn/DOT
John Thene, Wenck Associates, Inc.
Alan Palmer, Stanley Consultants, Inc.
Jessica Willey, Stanley Consultants, Inc.

Stanley Consultants INC.

MEETING NOTES

No. 002

Date: 07 September 2006

Place: Mn/DOT Waters Edge/ Lower Minnesota River Watershed District
Conference Call

Project/Purpose: I-494 Stormwater Alternatives

Attendees: Terry Schwalbe, Lower Minnesota River Watershed District
Beth Neuendorf, Mn/DOT
Julie Whitcher, Mn/DOT
John Thene, Wenck Associates, Inc.
Alan Palmer, Stanley Consultants, Inc.
Jessica Willey, Stanley Consultants, Inc.

Notes By: Jessica Willey

The following meeting notes set forth our understanding of the discussions and decisions made at this meeting. If you have any questions, additions, or comments, please contact the writer immediately. If we do not hear from you, we will assume that our understandings are the same. We are proceeding based on the contents of these meeting notes.

This purpose of this meeting was to document reactions from the Lower Minnesota Watershed District regarding the I-494 Stormwater Alternatives. Primarily, Mn/DOT wanted to know if they could be granted an exemption from the Watershed's discharge rate requirements.

Stanley handed out a power point presentation along with a set of plans and profiles for the project which included: introductions, analysis objectives, analysis preliminaries, hydraulic model and drainage alternatives. Stanley went over most of this presentation with Wenck discussing the hydraulics portion. Highlights included: narrowing the alternatives down to six, standards used for the hydraulic model, water quality control and discharge rate, peak rates match under both options and plans showing the existing system (store over 40 ac-ft for the 100-year event). Stanley also mentioned that since this project is very near the mouth of the Minnesota River and detention only lengthens the event by an hour or so, there would be little effect on the river or adjacent properties if our peak flow were allowed without detention.

Tunnel Advantages
Two years ago they talked about the tunnel providing some rate control which was considered in this alternative.

The water quality standard was met.

Tunnel Disadvantages
Storage concerns may become an issue along with sediment getting into the tunnel and then having to get the sediment out.

Mn/DOT has maintenance concerns with the tunnel alternative. It is much more difficult to clean out than a pond.

I-35W alternative is more expensive. There is not much reason to go down this corridor since there is nothing in Mn/DOT's plan to go down to the river. I-494 will be done before I-35 is even looked at. Bloomington wanted I-35W ponds and a tunnel, but the timing will not work.

The rate control standards could not be met. Terry recommended going with the best we could get.

The watershed has a five member Board. One Board member is not on board for this plan. We could look at what effect there is downstream, if any. The argument is localized storms. MAC has received the okay to discharge to the river at a higher rate based on the same information at this point. The contacts are Allan Dye or Bridget Rief.

The west pond is on Mn/DOT property. There is some opposition to maintenance from Fish and Wildlife. In the past there were conflicts between U.S. Fish and Wildlife and Mn/DOT in this area.

Ponds Advantages
It is much easier to clean out a pond than a tunnel.

Ponds Disadvantages
Using the existing system, we are restricted by the pipe capacity. This leads to flooding at most of the low points along I-494 (3-4 points) starting at the 5 year flood.

There was lots of resistance from the City of Bloomington.

Other Items
Normal flow rates on the Minnesota River are unknown.

Is a detention pond needed at the very end of the system before the river (is it worth the cost) or can the discharge just go straight to the river? There would be little effect on the river or adjacent properties if our peak flow were allowed without detention since our project is so close to the river.

If needed, the watershed has Fort Snelling River data as well.

The Fish and Wildlife pond is not an option to use, but the West pond could be used. The dredge material site would not interfere with the existing West pond. MAC is repairing the Cable Creek outlet and fixing up their pond soon as well.

We need to make sure all alternatives are looked into with box culverts and ROW. Economically some alternatives may not work. It is important to let the Board know as much information as possible. Representatives at the Boards meetings would also be helpful. Mn/DOT should show "hardship" to get the Board approval.

Anything that can be done to meet water quality needs is a plus. Will the Board get more restrictive in the future? Will they move more towards volume control? This all depends on the make-up of the Board when the new plan gets made in 2009-2012, although it is doubtful with the present Board. Mn/DOT may have a problem with volume control on this project. There is just not enough space. This may want to be addressed to the Board at this time with ROW cost going up daily.

Regarding rate control, are we affecting anything downstream? This is important to consider. At this point, there are just too many variables to determine the total affects, but it is doubtful that there would be much effect on the river or adjacent properties since the project is so close to the mouth of the Minnesota River and detention only lengthens the even by an hour or so. Is there anyway the Board would approve something with some certain conditions and regulations now? The Board may approve something like this with the help of their lawyer.

Regarding determination of downstream affect, the flow records nearby and state HEC-2 models should be reviewed. Look at a rate from a certain date and run the model to see the affect. Is stage more important? Combine flowrate and stage and then run the model again.

We would be better off if the Board accepts a simpler stage model. Otherwise the model may become too complex since there are a range of possibilities to consider. Do we want to pursue this at this time?

We would have to get a permit. This would include two Board meetings (at a minimum) with a presentation at the first meeting. The second meeting the Board would have time make a decision and ask questions. Then they would vote for approval. The Board meets once a month on the third Wednesday of every month. Mn/DOT is looking for a memorandum (Memo of Understanding) with a motion from the Board in writing. We would need as much back up data as possible with a preferred option (with doing a downstream analysis based on present conditions). We would still need a permit for construction and something about working together in the future on this project.

Project schedule and cost- John will meet with and discuss a game plan to the Board with Terry and Dan Engerton. We probably will not make the September Board meeting. John will set up this meeting and let Stanley know about a scope. Mn/DOT wants this meeting to be kept simple, but with enough detail so a decision can be made. Hopefully Dan can provide John with some feedback.

Distribution:

Beth Neuendorf, Mn/DOT
Julie Whitcher, Mn/DOT
John Thene, Wenck Associates, Inc.
Alan Palmer, Stanley Consultants, Inc.
Jessica Willey, Stanley Consultants, Inc.

Stanley Consultants INC.

MEETING NOTES

No. 003

Date: 07 September 2006

Place: City of Richfield

Project/Purpose: I-494 Stormwater Alternatives

Attendees: Kristin Asher, City of Richfield
Mike Eastling, City of Richfield
Julie Whitcher, Mn/DOT
John Thene, Wenck Associates, Inc.
Alan Palmer, Stanley Consultants, Inc.
Jessica Willey, Stanley Consultants, Inc.

Notes By: Jessica Willey

The following meeting notes set forth our understanding of the discussions and decisions made at this meeting. If you have any questions, additions, or comments, please contact the writer immediately. If we do not hear from you, we will assume that our understandings are the same. We are proceeding based on the contents of these meeting notes.

This purpose of this meeting was to document reactions from the City of Richfield regarding the I-494 Stormwater Alternatives.

Stanley handed out a power point presentation along with a set of plans and profiles for the project which included: introductions, analysis objectives, analysis preliminaries, hydraulic model and drainage alternatives. Stanley went over most of this presentation with Wenck discussing the hydraulics portion. Highlights included: narrowing the alternatives down to six, explanations why cut and fill was not practical, standards used for the hydraulic model, plans showing the existing system (store over 40 ac-ft for the 100-year event) and 20% of the drainage coming from Richfield (cost sharing will need to be determined when the project reaches the Staff Approved Layout stage of development).

Tunnel Advantages
Tunnels are not cheap, but the cost of the ponds alternative may be higher with having to acquire the land.

If any area of buried storage makes sense, this is the area.

All tunnel options would get rid of the pump at Penn Ave. Then the pump could be used at the leisure of the pump owner and not be programmed on a hydrograph schedule.

Tunnel Disadvantages
Maintenance costs and techniques for buried storage of this magnitude are hard to calculate because of the lack of existing comparable systems.

I-35W tunnel is probably not an option any longer since Bloomington cannot wait 20 plus years for Mn/DOT. Bloomington needs to fix their problems now.

What is maintenance problem with the tunnel if you can get a truck into it? Mn/DOT will need to get sediment out with a bobcat or liquidate it. What if there is a gas spill? Then they do not want people down there. The City of

Richfield suggested the following: looking into using remote control vehicles, technology will perhaps improve enough that this will not be an issue in the future, better street sweeping could be done to prevent build up of sediment in the tunnel (if you can get rid of the sediment on the surface it will help prevent problems), and maybe a stormcepter will work better to treat all of the water.

Ponds Advantages
Using the existing system with ponds is the most economical alternative (by $20 million) based on the original cost comparison done in 2005.

The ponds provide all the sediment and phosphorus removal that is needed.

Wood Lake is too high to use for I-494 drainage, but maybe water could be pumped to the lake. The City would work with Mn/DOT on this idea to take away some of the sags caused by some of the alternatives.

Wenck started at the east end of I-494 to see what the existing system could cover. It went to about 77th St. To make things easier, perhaps a tunnel could be used to Lyndale and then ponds could be used from Lyndale on.

Ponds Disadvantages
The Hennepin County Assessor's site was used for the cost estimate. Richfield would double the property cost listed on that site.

The combination of cost and disruption to the City is very high.

A surface solution would create massive political problems. The City took some homes to get 77th St. already and they had some tough issues with residential properties versus commercial properties. Richfield's land use plan is already done and if it gets changed now it will be politically very difficult.

The location of the ponds is subject to change and there may be more located in Richfield.

Other Items
The EIS for I-494 included 77th and American Blvd. which was included in our model.

I-494 is not that much higher than the groundwater elevation.

The City has an issue with flooding at Smith pond but it is too high to be a concern for this project.

Mn/DOT still needs a larger solution to deal with the drainage issue for I-494. They may be able to find 40 acre-feet, but not at the right elevation. Smaller micro solutions do little to help the problem.

Nicollet could possibly be raised to help give more space for I-494. Lyndale will have a new bridge in 2009, so the City will have to know what the long term drainage solution is before then. The entire ROW was used at Lyndale Ave. If the tunnel solution is the chosen alternative, then it will not matter what is on the surface.

The City has a problem with the Wilson pond drainage area. It is about 100 acres on the east side of the city that is very flat with ponding problems. The City is not sure if there is a large enough pipe to get the water to the I-494 system, but any help Mn/DOT could provide would be good. Mn/DOT suggested some sort of cost share on a percentage basis with the tunnel option. The City probably would not invest in this option since it would be cheaper for them to just demolition a few homes and put in a pond.

Distribution:

Beth Neuendorf, Mn/DOT
Julie Whitcher, Mn/DOT
John Thene, Wenck Associates, Inc.

Alan Palmer, Stanley Consultants, Inc.
Jessica Willey, Stanley Consultants, Inc.

Stanley Consultants INC.

MEETING NOTES

No. 004

Date: 11 September 2006

Place: Nine Mile Creek Watershed District

Project/Purpose: I-494 Stormwater Alternatives

Attendees: Kevin Bigalke, Nine Mile Creek Watershed District
Bob Obermeyer, Barr Engineering
Beth Neuendorf, Mn/DOT
Julie Whitcher, Mn/DOT
John Thene, Wenck Associates, Inc.
Alan Palmer, Stanley Consultants, Inc.
Jessica Willey, Stanley Consultants, Inc.

Notes By: Jessica Willey

The following meeting notes set forth our understanding of the discussions and decisions made at this meeting. If you have any questions, additions, or comments, please contact the writer immediately. If we do not hear from you, we will assume that our understandings are the same. We are proceeding based on the contents of these meeting notes.

This purpose of this meeting was to document reactions from the Nine Mile Creek Watershed District regarding the I-494 Stormwater Alternatives.

Stanley handed out a power point presentation along with a set of plans and profiles for the project which included: introductions, analysis objectives, analysis preliminaries, hydraulic model and drainage alternatives. Stanley went over most of this presentation with Wenck discussing the hydraulics portion. Highlights included: narrowing the alternatives down to six, standards used for the hydraulic model, discharge ponds, discharge peaks (different with storage for the various alternatives, but volumes are similar), meetings with Lower Minnesota River Watershed District to discuss options of discharge without storage, existing system pipes, plans showing the existing system (store over 40 ac-ft for the 100-year event), and 60% of the drainage coming from Mn/DOT.

Tunnel Advantages
Mn/DOT is an MS4 permit owner, but they are not under the non-degradation standards.

The I-35W tunnel option was appealing to pickup some of the watershed's water and solves some of their problems. Nine Mile Creek is impaired for chloride. Water drains south on I-35W to the river and it could pickup some of the I-494 drainage.

Volume reduction is on a municipal boundary basis. If standards did apply we could still take the water down to the river and treat it at those ponds.

Less land is needed for this alternative.

Volume (rate control) is the only major issue that is a problem. Both water quality and sediment will be improved.

Tunnel Disadvantages
Mn/DOT will not do the I-35W tunnel since the timing is not good with the City of Bloomington (timeframe of

Mn/DOT is too far out for Bloomington).

There could be issues with I-35W and the ponds in Bloomington below the bluff. The ponds are not meeting capacity and need maintenance, but they will not be maintained without first providing the necessary above the bluff treatment. This is per the U.S. Fish and Wildlife Service and these are City of Bloomington ponds. There could be problems with U.S. Fish and Wildlife if we intend to add ponds below the bluff in the future with the I-494 project or the I-35W project.

The biggest issue for the watershed is that we may need to consider incorporating non-degradation standards in the future since they may eventually apply (they apply to Bloomington right now, but not Richfield). Current standards should be looked at and considered (any level of standards are good to consider). (These are MPCA requirements, not the watershed district requirements). Mn/DOT may want to discuss this with MPCA to see what they say regarding future issues. This will help with getting a more accurate cost estimate (since otherwise may be way off unless we meet the maximum permit amount). The MPCA test case (with regard to standards) will probably get stricter in the future, but they will have to see how the test case works. TMDL "may" be an issue with regard to Lake Pepin.

The large scale storage examples that the watershed is aware of include: Hopkins, the old Bloomington City Hall and the Airport (basically a septic tank the size of three football fields). The MAC contacts are Gary Worn and Alan Dye. Some phosphorus removal would still be needed for longer term detention downstream. Jay Michaels with EOR may be a good contact as well (low impact development and MN Erosion Control Association).

Ponds Advantages
Surface storage takes care of water quality issue and the ponds are easier to clean.

The west pond is large enough to handle the water. Mn/DOT will swap land with the Refuge to get the needed space.

Ponds Disadvantages
More land is needed beyond the ROW.

Since I-494 is in a trench, it makes the alternatives more complicated since ponds will have to be 20 feet below ground to get water. (This does not apply to the ponds near the river, just those along the corridor.)

I-494 will not be widened, but the intersections may be widened if ponds are added. ROW will then be needed when these intersections are widened, and some of this ROW could possibly be used for ponding.

Other Items
The watershed boundaries for this project are: Penn to Nicollet (southside), east of Nicollet (southside) is part of the Lower MN watershed, and the northside is WMO property. Nine Mile Creek Watershed review and comment would stop at Nicollet.

The best storage area for the watershed is right at Penn Ave. where the freeway is located.

Nine Mile Creek is too far from the river to directly discharge into the river.

Rate control is project to project based.

Nine Mile Creek Watershed District is in the process of updating their rules. They plan on spending 2007 updating them. They may change them on a case by case basis or all at once.

Does Lower MN defer permitting to the cities? The Lower MN will comment, but they do not have any official permit that they give out. Projects are submitted to the cities and they give them to the watersheds to review and comment. They were not sure how it works with MAC.

For these alternatives, we are not getting any public input at this time. This is because we are not doing an EIS/AUAR; we are just finishing up the drainage study. We are just gathering input from the major parties and Mn/DOT will decide on an alternative later (maybe in 5 years) and then the cities can plan accordingly. At that point regulations may be clearer.

Distribution:

Beth Neuendorf, Mn/DOT
Julie Whitcher, Mn/DOT
John Thene, Wenck Associates, Inc.
Alan Palmer, Stanley Consultants, Inc.
Jessica Willey, Stanley Consultants, Inc.

Stanley Consultants INC.

TELEPHONE CALL REPORT

Date:	September 26, 2006	**Time:** 0900	**Project No.:** 19636.01.00
To:	Allen Dye, Airside Project Manager	**Representing:**	Metropolitan Airports Commission
Location:	Minneapolis, Minnesota	**Phone No.:**	1.612.713.7492
From:	Alan Palmer	**Representing:**	Stanley Consultants, Inc.
Location:	St. Louis Park, MN	**Phone No.:**	1.952.546.3669

Subject: I-494 Stormwater Alternatives - Underground Storage

In 2002, the Metropolitan Airports Commission (MAC) constructed an 11,000,000 gallon cast in place, buried facility to collect waste glycol from the airport's deicing facilities. I called to get a better idea as to the size and scope of their project.

Prior to this facility, waste glycol (glycol mixed with melted ice, snow, and rainwater) was collected in three small ponds adjacent to the deicing pads. The total volume of these ponds was approximately 1,500,000 gallons, or 4.6 acre-feet. During the planning for their recent runway additions, the MAC decided to provide waste glycol storage underground, which would provide better containment and increased storage volumes.

The volume of the new facilities is approximately 11,000,000 gallons, or roughly 34 acre-feet. It is configured from three cells, each 16 feet in height. Dye recalled that the total length of the facility was roughly twice the total width. As such, the rough footprint of the facility could be approximately 200 feet by 450 feet, or three cells at 200 feet by 150 feet. The cells were cast in place "bathtubs", with a column supported roof made of precast "T" sections. The top of the roof is at ground level. A collection of valves controls the inflow and gates interconnect each of the three cells; this allows the cells to be used independently.

Waste glycol is transported to the storage facility through gravity sewers (for nearby deicing pads) and by tanker truck (from remote deicing pads). The waste glycol is then processed through a system of filters and evaporators and is then reused to deice aircraft again, or to provide lavatory fluid for in-flight facilities.

On an annual basis, maintenance crews are sent into the storage cells and remove any accumulated sand and silt. The crews usually are equipped with high pressure hoses, which they use to force the debris into a sump area to one end of the cell. From here, the particulates are removed by vacuum and landfilled. As glycol is not volatile, the quality of the atmosphere in the cells is not an issue. However, cleaning crews are outfitted with "sniffers" to monitor the quality of the air while they are underground.

Stanley Consultants INC.

TELEPHONE CALL REPORT

Date:	October 4, 2006	**Time:** 10:45	**Project No.:** 19636.01.00
To:	Tim Anderson, Area Engineer	**Representing:**	FHWA
Location:	St. Paul, MN	**Phone No.:**	651.291.6114
From:	Alan Palmer	**Representing:**	Stanley Consultants, Inc.
Location:	St. Louis Park, MN	**Phone No.:**	952.797.5387
Subject:	I-494 Stormwater Alternatives		

I called Tim Anderson to discuss I-494 Stormwater Alternatives study. I gave him a brief explanation of the history of the project, the process for this phase of the work, and the various alternatives that we are considering. Most of our time was spent discussing the buried storage concept, the key points which are highlighted below.

- Right-of-way has become an increasingly costly portion of roadway improvements, especially in urban and commercial settings. With right-of-way as a constraint, more creative methods for dealing with stormwater must be considered.

- Although Tim could not recall any Interstate location where buried storage under the roadway had been used, he saw it as a natural progression in response to the lack of available and adjacent lands for detention storage purposes. Tim felt that these systems were inevitable.

- The underground storage cells that Stanley is proposing for this project are simply box culvert sections, a technology that has been tested extensively under the interstate highway system for decades. From a structural and hydraulic standpoint, the design would be straightforward.

- As the first flush of stormwater through the system would be bypassed around the storage cells, the bulk of any particulate load would also bypass the system. The system could also be designed to fill from and drain to a single sump, thereby collecting any remaining particulates within a single, easy to clean, point.

- As above, the first flush would also eliminate any potential fuel spills that drained into the storm sewer system. Fuel spills during dry weather would bypass the storage system and be routed downstream. Fuel spills during large storm events would be diluted by the storm and conveyed out of the system as the storage cells discharged. This is not dissimilar from what occurs in traditional storm sewers today.

Wenck

RECEIVED
OCT 17 2006
STANLEY CONSULTANTS
MINNEAPOLIS

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1800 Pioneer Creek Ctr.
P.O. Box 249
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E-mail: wenckmp@wenck.com

October 12, 2006

Mr. Terry Schwalbe, Administrator
Board of Managers
Lower Minnesota River Watershed District
1600 Bavaria Road
Chaska, MN 55318

Re: I-494 Drainage Alternatives Analysis

Dear Mr. Schwalbe:
Dear Board of Managers:

Working on behalf of MnDOT, Wenck is teamed with Stanley Consultants, Inc. to study and compare drainage alternatives for the portion of I-494 from Penn Avenue to the Minnesota River crossing. Our study will compare six main alternatives to drain the corridor, with the future reconstruction of the roadway. (Note that the project currently is not in MnDOT's 20-year plan.) Each alternative will be designed to meet relevant rules in terms of water quality and discharge rate, including those of the Lower Minnesota River Watershed District.

This letter is to inform you of our hydrologic design activities related to the referenced study. Specifically, we plan to, on behalf of MnDOT, request a resolution of your Board agreeing in principal that detention storage would not be required to match the existing peak discharge rates at the project outfalls to the Minnesota River. The project would meet all other rules, including water quality.

Since the existing drainage system is under-capacity, surface flooding occurs for large storm events and limits the system discharge. Once flooding is eliminated in the future project, the peak discharge will increase. However, for both the with- and without-detention conditions, most of the water volume from the project drains to the river within approximately five hours. Given the size and timing of flooding on the Minnesota River, and the relatively small volume from I-494, detaining the water is likely to have no benefit in terms of peak flood stages. That is, in both cases, the peak on the River will occur much later than the discharge from the I-494 drainage system. A memo comparing the hydrographs is attached.
MnDOT, Wenck and Stanley staff have already met with Terry Schwalbe, and I have met with your Engineer Dan Edgerton to explain the project and discuss the kinds of additional supporting documentation which may be useful to the Board of Managers in reaching a conclusion. We will provide you with that information and would like to request an opportunity to present it to the Board at its December 20, 2006 meeting. As

we discussed with Terry, with your agreement, we would then work with him to draft resolution language, and attend your next meeting in January to answer any questions before you act on the resolution.

In addition to the attached hydrograph analysis, we plan to prepare and document for you the following in support of the resolution:

- Relevant data from previous studies.
- Discharge hydrograph analysis (XP-SWMM) of the I-494 corridor as documented previously.
- Analysis of project effects on Minnesota River hydrographs in terms of timing and rate for the October 4, 2005 large storm event.
- Analysis of potential stage effects of the project on stages on the Minnesota River.
- General description of the outfall structure to the Minnesota River and the types of measures that would be employed to control localized erosion at the site.
- Documentation of any hardship conditions (e.g., conveyance reduction due to the construction of a pond, difficulty in operation of an orifice on an underground tunnel/storage facility) that would result from rate control requirements.

MnDOT would most certainly appreciate any preliminary comments or concerns you may have with our approach or objectives. Please contact me with any of your concerns at 763 479 4234.

Sincerely,

WENCK ASSOCIATES, INC.

John R. Thene, P.E.
Principal Engineer

cc: Beth Neuendorf, P.E., Metro District Water Resources Engineer, MnDOT
Alan J. Palmer, P.E., Principal Transportation Engineer, Stanley Consultants, Inc.

LOWER MINNESOTA RIVER WATERSHED DISTRICT
MONTHLY MEETING
Wednesday, January 17, 2007 7:00 PM
MINUTES

I. CALL TO ORDER
President Kremer called the regular meeting of the Board of Managers of the Lower Minnesota River Watershed District to order at 7:00 PM on Wednesday, January 17, 2007, in the City of Chaska Council Chambers, Chaska, Minnesota.

2. ROLL CALL
Managers Present: Len Kremer, Larry Samstad, Kent Francis, and Ed Schlampp, Ron Kraemer

Also Present: Terry Schwalbe and Joan Ellis, staff, John Thene, Wenck & Associates

3. APPROVAL OF MEETING AGENDA
It was moved and seconded to approve the agenda. VOTE: Ayes 5; Nays 0.

4. CONSENT AGENDA
President Kremer removed the Review and Payment of Bills and the Minutes of December 20, 2006 from the Consent Agenda. It was then moved and seconded to approve the Consent Agenda including only the December 20, 2006 Treasurer's Report. VOTE: Ayes: 5 Nays: 0.

5. APPROVAL OF MINUTES
a. December 20, 2006 Regular Minutes
President Kremer indicated a spelling error on page three, paragraph four, the word "sold" should be "solid" in the sentence. Also, he stated there was no timeline stated in the minutes for when the solid recommendation for one or two potential dredge sites would come back to the board from staff. Mr. Malkerson said the recommendation is coming before the board this evening. **It was moved and seconded to approve the minutes as amended. VOTE: Ayes 5; Nays 0.**

6. OPEN FORUM
No one spoke.

7. PRESENTATIONS
None.

8. PRESENTATIONS FOR BOARD ACTION
a. I-494 Drainage Alternatives Analysis, John Thene, Wenck & Associates
Mr. Thene presented the Interstate 494 Stormwater Alternatives Analysis to the board. A copy of the presentation is hereby attached and made a permanent part of the public record. This project is not currently in MNDot's 20-year plan. The drainage component of the project has a cost ranging from $50 to $120 million dollars depending on which option is chosen.

Alternative 1C is the conveyance tunnel with downstream detention
This plan is the one of most interest to our District. It is tunnel that from Penn Avenue to the Minnesota River. They would need to build a West Pond water quality site as shown on the schematic attached to meet our rules. This Alternative 1C cost is approximately $120 million. The tunnel will be placed 100 feet below grade approximately, with a circumference of 9-10 feet with a length of five miles.

Alternative 2A,2C, use existing trunk sewer with adjacent ponding.
Cost ranges from $50 to $80 million.
Ponding would be open at the surface

Alternative 2D use existing trunk sewer with buried ponding under roadway.
Cost ranges from $50 to $80 million.

Alternatives 5A storage tunnel with gravity outfall and 5B storage tunnel with pumped outfall
This plan is designed to store all the water on-site in the event of a 100-year flood. Costs ranges in the intermediate area between $50 and $120 million.

All alternatives have water quality detention with upstream ponding variants controlling discharge rate to existing peak. Phosphorus removal is 50% removal from the entire tributary of the highway.
The tunnel alternative, without storage, would have a peak of 1,140 cfs for a 100-year event. Detention would delay discharge of volume by roughly two hours. The expansion causes the increase in cfs rate and includes one-lane in each direction. Current rate of discharge is 470 cfs.

Existing peak rates are limited by the system and with or without rate control, most of the flow will reach the river within five hours. Due to the timing of peaks on the river, it is unlikely that detention for two hours and rate control would affect peak water levels and flows on the river. Presence of a rate control pond near the river could reduce floodplain conveyance.

Proposing to conduct a simple analysis to estimate effect of detention storage, discuss the results with the engineer and Administrator and then present results next month and determine if a Board resolution saying that you would not require detention storage for rate control for this particular project ten to twenty years from now under the existing, current regulations and conditions of the District. The resolution would not be binding on a future board.

Mr. Malkerson clarified Mr. Thene's request by saying that the resolution would be conceptual approval without being binding and when MNDot comes to the District sometime in the future with the expansion of the highway plan, with the proposed drainage plans it would be hoped that a future District board would give some weight to the resolution approved by this board. The resolution only applies to 1C plan, but Mr. Thene will confirm that statement to us. Also, this resolution is necessary for developing the drainage plan.

President Kremer stated a few reasons for doing a resolution:
1. excessively costly project
2. there would be impacts of construction on the river
3. the timing of the peak of the project coinciding with the timing of the peak of the river

He asked what the economic impact is of doing the project without providing the detention pond. Mr. Thene did not have the number. The board would need that number to help make a decision.
2D is considered the least expensive project.

MNDot will choose the right plan after they complete their study.
President Kremer stated that water quality treatment on this project is very important to the District.

Mr. Thene will return to the board with the following information:
1. Reasons for why 2D is considered the least expensive project
2. What is the economic impact of doing the project without providing the detention pond
3. What is the daily fuels accumulation off the highway and what is the plan to protect the river
4. What is your spill response plan to protect the river at the last point before entering the river?
5. As high as possible sediment and phosphorus removal than 50% for water quality purposes
6. What is MN/Dot's rules for reducing volume control-runoff frequency relationships on new development?
7. Permanent reductions in groundwater
8. What is the quantity of water coming into the river and at what cfs?
9. What structures would be used to limit the surge and velocity of water into the river that may affect the active barge traffic
10. Draft language on a resolution

Project manager at MN/Dot is Beth Neuendorf.

Manager Samstad brought to Mr. Thene's attention a study by TKDA on the Smith, _____? And Rice Lake for the City of Bloomington. The commission number is 9055 and it shows that it takes a large area out to the MN River.

Also he said the weather bureau has stated that in 18 years, the 100-year event was exceeded 60 times. He thinks Mr. Thene should use those facts rather than the TP40 which is a poor representation of frequency.

b. BRAA's cost quote for a District-wide computerized mapping system
Mr. Schwalbe explained the cost quote submitted by BRAA to develop a district-wide computerized GIS mapping system. Cost for the mapping would be $2,600 and cost for four hours of staff training would be $425 for a total of $3,025.

President Kremer inquired whether our current computer system can use ESRA and also there is the concern of printer capabilities. Mr. Schwalbe will research these issues.

It was moved and seconded to approve a not to exceed amount of $1,000 to complete the mapping of the gully inventory by the next board meeting to make it available to the cities.
VOTE: Ayes 4; Nays 0. Mr. Samstad was absent for this vote.

9. DISTRICT ATTORNEY REPORT, Bruce Malkerson

a. Assessment update

Mr. Malkerson explained the research currently being done by BRAA, Mr. Schwalbe and himself to come up with conclusions needed. Maps created as a result of the research were shown to the board with the needed data on the maps.

Mr. Schwalbe is meeting with the cities to determine what developments are planned and how those developments might benefit from the Nine-foot Channel.

Once all the maps and other materials are completed, then Mr. Schwalbe will meet with each of the property owners before the next meeting to show them the materials and maps we have and determine the accuracy of those materials and maps and determine who directly benefits from access to the Nine-foot Channel among other things. Then we will be able to tell the board how much the special assessment should be as a whole, how it should be spread between the land owners and why.

In order to determine if the dredge materials are clean and meet county and state health standards for using in farm fields, etc. we feel it is necessary to have the authority to hire a testing firm to get the protocol for testing of the dredge materials to determine what they are composed of and what will come down the river in the next two years into our site. Also, we need to find out from the MPCA and any other necessary agencies are these materials, in any way, restricted as to where they can be placed when leaving our site. If they are, then we need to find out where they can be safely placed.

It was moved and seconded to authorize not to exceed amounts of $1,000 for dredge material sampling and $1,000 for engineering testing if the MPCA, Barr Engineering, and the private industry don't give us the information we need at no cost; and a not to exceed amount of $2,000 for legal advice should it be needed in regards to the dredge material content results.
VOTE: Ayes 5; Nays 0

b. Update on dredge sites

Mr. Malkerson said he and Mr. Schwalbe have been working this past month to determine a recommendation for the board. Research has been done at the 494 and power line sites. MN/Dot has concerns at their site that 1) someone may compromise the structure of the bridge when unloading; 2) the bridge piers may get damaged by off-loading and 3) does not want to be liable for materials.

It was a recommendation to the board that the District pursue the power line site.

Mr. Schwalbe was directed to talk to the USACOE and the military to get a letter of support for this site.

It was moved and seconded for Mr. Schwalbe to contact the USACOE and the military to start negotiations for using the power line site as a dredge material temporary storage site.
VOTE: Ayes 5; Nays 0.

10. Upcoming Meetings/ Tours/ Events

a. There is a Minnesota River Watershed Alliance meeting January 23, 2007 6-9 PM, Hutchinson, MN

11. TREASURER'S REPORT

a. Review and approval of bills for payment*

Because staff did not place the BRAA bill in the board packet, their check was pulled from the bills for payment. **It was moved and seconded to remove the BRAA bill from payment and approve the review and approval of the balance of the bills for payment. VOTE: Ayes 5; Nays 0.**

b. Approve December 2006 Treasurer's Report*

The 2006 budget figures were reviewed by the board and staff. Mr. Schwalbe will bring to the next board meeting a review of monies expended and monies not expended in 2006. Mr. Schwalbe will meet with HLB Tautges Redpath to review the year end budget figures and make amendments as needed. **It was moved and seconded to approve the December 2006 Treasurer's Report as presented. VOTE: Ayes 5; Nays 0.**

12. OLD BUSINESS

a. Municipal plan review status

Mr. Schwalbe presented information on his meeting with Scott County in regards to the two townships within our District and how best to assist them in meeting our 509 Plan. At some point in the future

13. NEW BUSINESS

None.

14. ADMINISTRATOR'S REPORT

a. Update on Seminary Fen/Assumption Creek

Mr. Schwalbe reviewed the map in their packet showing parcel numbers and property owner names around the Seminary Fen. He indicated there is a meeting on the fen Phase II at the DNR January 24th.

b. Update on dredge sites

Discussed under Item 9.

c. MRB Conference Review

There was lengthy discussion about the conference and the outcomes.

15. ADJOURN

It was moved and seconded to adjourn the meeting at 9:05 P.M. VOTE: Ayes 5; Nays 0.

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TECHNICAL MEMORANDUM

TO: Alan Palmer, P.E., Stanley Consultants
Beth Neuendorf, P.E., MnDOT

FROM: John R. Thene, P.E., Wenck Associates, Inc.

DATE: February 1, 2007

SUBJECT: I-494 Drainge Alternatives Study
Standards for H&H Design of I-494, Penn Avenue to Minnesota River

CC: Chris Meehan, P.E., Wenck Associates, Inc.

Introduction

This memorandum is to document proposed standards for the preliminary hydrologic and hydraulic design of the trunk conveyance and storage system on I-494 from Penn Avenue to the Minnesota River. The standards are based on:

- MnDOT Drainage Manual;
- Interpretations by the MnDOT project manager for the earlier phase of this project;
- Lower Minnesota River Watershed District Project Review Requirements and Design Considerations.

Most of the discussion which follows is based on the standards included in the June 2005 I-494 Drainage Feasibility Study (Stanley, 2005). Requirements suggested by the LMRWD Board of Managers at their January 17, 2007 meeting are also discussed.

This memo is being provided to MnDOT for review prior to re-analysis / refinement of the H&H design calculations for the present alternatives investigation. It should be used to develop final design standards used in the alternative designs.

Conveyance System Hydrologic and Hydraulic Design

The Mn/DOT Drainage Manual on (Section 8.9) states that, *"For ordinary conditions, storm drains should be sized on the assumption that they will flow full or practically full under the design discharge but will not flow under pressure head."* The Manual then states that *"The exceptions are depressed sections and underpasses where ponded water can be removed only through the storm drain system. In these situations, a 50-year frequency design should be used to design the storm drain which drains the sag point. The main storm drain which drains the depressed section should be designed by computing the hydraulic grade line and keeping the water surface elevations below the grates and/or established critical elevations."*

In the I-494 corridor, the design storm is the 50-year event according to Table 3.2 of the Mn/DOT Drainage Manual. So, the exception in Section 8.9 allowing the hydraulic grade line (HGL, or pressure gradient) to be above the crown but below the inlets is (in this case) less conservative.

Therefore, the standard proposed, and confirmed by Dennis Larson, was that the 50-year event will be carried within the pipe without surcharging. A second standard confirmed by him is that the 100-year event will be kept below the grates, i.e., there will be no surface flooding. These standards play out differently in the alternatives:

- By preventing surcharging in the conveyance tunnel (Alternative 1), this reduces the possibility of air problems in the tunnel up to the 50-year event. However, the tunnel diameter may be increased compared to a system where surcharging is allowed. Allowing surcharging in the 100-year event the tunnel system may be more susceptible to air problems. (These standards apply similarly to Alternatives 3 and 4, the tunnels along TH-77 and I-35W, respectively.)
- In Alternative 2 the existing sewer is re-used with ponding adjacent to low points. The standards do not have a substantial effect on the design since the required live storage is at least one quarter of design event runoff volume. Due to the low vertical clearance between the crown of the pipes and the roadway, the live storage bounce is limited. Allowing surcharging at the 50-year event would not be significantly improve the capacity of the system, but increase the likelihood of surface flooding.
- Alternative 5 is the storage tunnel; it is sized based on excess runoff volume and fills during the 100-year event. The conveyance/design frequency standard would not affect on the volume of the tunnel.

Outfall Location.
The outfall will be to the Minnesota River. Whether the outfall is at West Pond, or at the extension of I-35W, the outfall will be within the Lower Minnesota River Watershed District (LMRWD), and subject to its Design Considerations. At the West Pond site, the outfall would require a permit from the LMRWD. At the 35W site, the outfall would also be subject to the LMRWD Design Considerations, which would be enforced through permitting by the City of Bloomington.[1] Relevant Minnesota River elevations at West Pond include El. 690 MSL at normal conditions, and El. 715 MSL at the 100-year flood (Source: FEMA. City of Bloomington Flood Insurance Study Report).

Rate Control
LMRWD Design Considerations require that the peak rate of stormwater runoff from the future developed watershed or project shall not exceed the peak rate of runoff from the existing watershed or project. Thus rate control facilities will be required to limit the peak discharge from the proposed system.

An exemption may be possible by maintaining that the short detention times required to match peaks is too short to reduce peak flood stages on a river the size of the Minnesota. Also, by detaining water in the system, it is more likely to reach the river at the same time as flood flows from the upstream portion of the watershed. Currently Wenck is producing a simple analysis to support a resolution by the LMRWD Board to waive the requirement of rate control. The exemption would benefit the conveyance tunnel (Alternative 1C) by eliminating the requirement for downstream retention. The ponding alternatives (Alternative 2A through 2E) would not be affected since they require storage in order utilize the existing storm sewer discharge capacity; the discharge will be limited to less than the existing surcharged (flooded) capacities.

---

[1] Personal communication with LMRWD Administrator Terry Schwalbe.

If an exemption cannot be acquired, the LMRWD will require that post-project peak runoff rates not exceed peak rates from the pre-project condition. The pre-project peak rates from the project would be limited to the existing peaks from the surcharged system (with surface flooding of low points). As a model of the existing I-494 corridor runoff was not available, the base model, with the post-project condition and the existing trunk sewer system was used to determine the existing peak discharge. The proposed conditions peak discharge is controlled by the existing trunk system capacity, not the runoff rate, during both the 50- and 100-year storms. Significant surface flooding and surcharging of the system act to store water and limit discharge. The evaluation showed that the peak discharge from the existing system under proposed conditions (including discharge from Almaz Pond and by-pass) to the Minnesota River was:

- 433 cfs from the 50-year storm, and
- 467 cfs from the 100-year storm.

Without an exemption for the LMRWD rate control requirement, these will be the maximum discharge rates allowed from the future I-494 corridor. The additional flow during the 100-year event is due to increased runoff and surcharging in the downstream portions of the system (i.e. International Drive to the River) which do not flood during either event. The peak discharge rates from the Alternative 1C tunnel with no detention would be 980 and 1,140 cfs for the 50- and 100-year events, respectively.

Water Quality

The Minnesota River is classified as a Level II/Level III Water Resource within the LMRWD Classifications. This results in a requirement of water quality detention ponds with specific design requirements as listed in Section 5.13.3 of the LMRWD Watershed Management Plan. The Design Considerations require that the permanent pool volume below the normal outlet be at least equal to the runoff from a 2.5 inch, 24-hour storm over the entire subwatershed. This is equivalent to NURP standards where the aim is to develop an average residence time of about 16 days and remove approximately 50 percent of inflow phosphorus.

The XP-SWMM model was used to determine the dead volume requirement for a regional water quality pond. The dead volume requirement by MPCA (1999) for a pond discharging to a Level II water resource is equal to runoff from a 2.5-inch, 24-hour storm over the entire subwatershed, or over the entire project site for the on-site basins. For this project, the volume of runoff from this event is 52 acre-feet. This is the volume that would be required for a single pond treating runoff from the entire drainage area.

The available dead volume at the existing water quality pond (Almaz Pond) is 19 acre-feet. In the case of the I-494 corridor, the 52 acre-feet of required water quality treatment volume cannot all occur at Almaz Pond therefore, a system of ponds is required.

Conveyance alternatives that overload Almaz Pond will require that other ponds in the system be oversized to provide equivalent treatment. The MPCA criteria uses 2.0-inches for treatment, plus 0.5

inch to provide for sediment storage. As such, 80 percent of the dead volume is considered adequate for the required 50 percent removal of phosphorus.

Analytical Methods

Watershed and Drainage System Evaluation Model

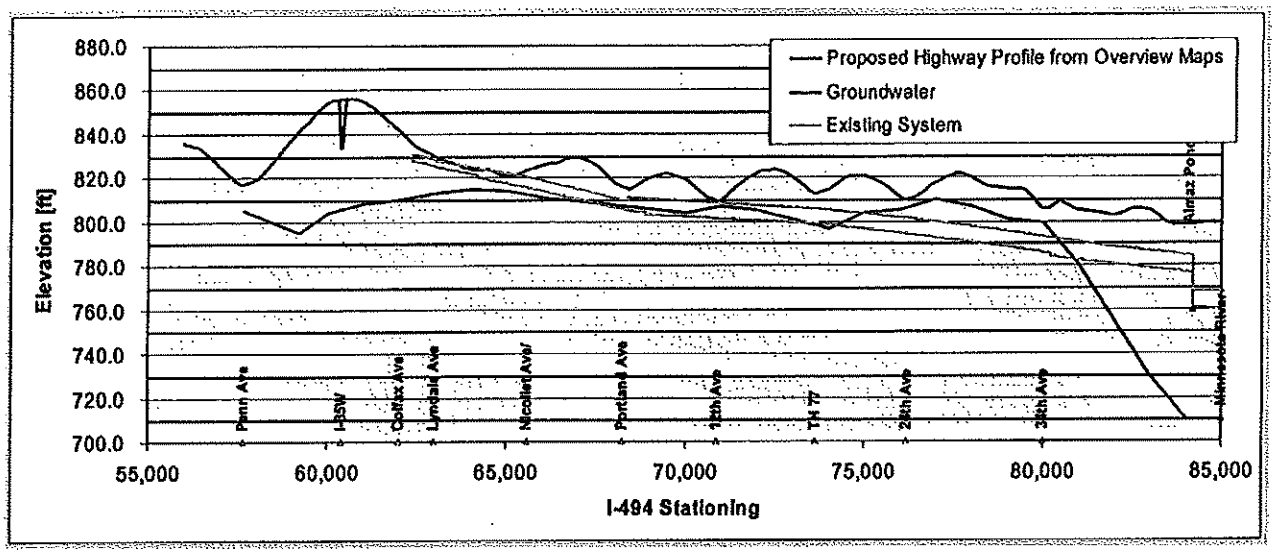
An XP-SWMM computer model was used to evaluate the hydraulic performance of alternative drainage systems for the I-494 Drainage Feasibility Study. XP-SWMM is the commercial version of the USEPA's Stormwater Management Model. It is a dynamic model which simulates rainfall runoff and performs hydraulic routing of discharge through pipe, pond and channel systems with free-surface and pressurized flow. Its advantage over simpler models is that it can simulate critical conditions (flooding and surcharging) when downstream pipe capacities are inadequate. A second advantage is that the runoff and hydraulic models are completed in a single simulation.

The model inputs describe the hydrologic characteristics of the watershed as well as the sizes, grades and capacities of conveyance system. The XP-SWMM model is based on the model developed for the Tunnel Feasibility Study (TFS, 2002). The model was subjected to a review of basic inputs in the earlier phase of this study. As a result of that review, several changes were made to the model as summarized below:

Summary of XP-SWMM Model Input Parameters

Model Parameter	Value
Drainage Area	438 acres
Subwatersheds	38 Subwatersheds; Average size: 11.5 acres Range: 1.4 to 53 acres
SCS Curve Number	Average: 89 Range: 77 to 98
Subwatershed Time of Concentration	Average: 17 min Range: 7 to 48
Existing conveyance system	See profile below.
Rainfall amounts (24-hour, SCS Type II distribution)	50-year: 5.3 inches 100-year: 5.9 inches
Almaz Pond	Area: 3.2 acres Volume: 19 ac-ft at El. 760

Model inputs were calculated according to the MnDOT Drainage Manual.



Proposed I-494 Profile, Existing Trunk Sewer System Profile

Water Quality Pond Sizing

The water quality ponds are sized according to LMRWD (and NURP) standards with the dead volume equal to runoff from the 2.5-inch, 24-hour storm. However, in some alternatives, water flows through both the low point ponds and through the Almaz Pond. In these cases of ponds in series, the phosphorus removal was estimated using the PondNet model (Walker), which is the basis for the NURP performance criteria. Pond dead volumes were adjusted according to a total removal of 50 percent.

Lower Minnesota River Watershed District Requests

During the January 17, 2007 Board Meeting, the LMRWD Managers requested that MnDOT consider some higher standards in its designs. These are noted below with the MnDOT response, as noted by Beth Neuendorf:

LMRWD Manager Request	MnDOT Response
As high as possible sediment and phosphorus removal; more than 50% phosphorus removal for water quality purposes.	MnDOT will follow the Design Considerations which are based on runoff volume from the 2.5-inch, 24-hour storm (NURP standard), or its equivalent of 50 percent phosphorus removal
What are MnDOT's rules for reducing volume control-runoff frequency relationships on new development?	MnDOT is not presently required to control runoff volume.
Permanent reductions in groundwater.	The tunnel would be designed to be water tight and not affect groundwater. Ponds would be designed with runouts at the water table elevation.

What structures would be used to limit the surge and velocity of water into the river that may affect the active barge traffic.	Energy dissipation structures will be described in the report.
One of the managers suggested MnDOT consider larger design storms; he suggested that the TP40 values have been exceeded much more frequently than the analysis would suggest.	MnDOT will design according to TP-40, unless that standard is replaced.

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TECHNICAL MEMORANDUM

TO: Alan Palmer, P.E., Transportation Engineer, Stanley Consultants, Inc.

FROM: John Thene, P.E. and Chris Meehan, P.E.

DATE: February 21, 2007

SUBJECT: MnDOT – I-494 Stormwater Alternatives Study (Penn Avenue to Minnesota River) Technical support for resolution by Lower Minnesota River Watershed District Board regarding rate control requirements

COPY: Beth Neuendorf, P.E., Metro District Water Resources Engineer, MnDOT

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1 Introduction

Working on behalf of MnDOT, Wenck is teamed with Stanley Consultants, Inc. to study and compare drainage alternatives for the portion of I-494 from Penn Avenue to the Minnesota River crossing. Our study is comparing six main alternatives to drain the corridor, with the future reconstruction of the roadway. (Note that the project currently is not in MnDOT's 20-year plan.) Each alternative will be designed to meet relevant rules in terms of water quality and discharge rate, including those of the Lower Minnesota River Watershed District.

At the January 17, 2007 LMRWD Board Meeting, John Thene explained our hydrologic design activities related to the referenced study. Specifically, on behalf of MnDOT, we are requesting a resolution of the Board agreeing in principal that detention storage would not be required to match the existing peak discharge rates at the project outfalls to the Minnesota River. The project would meet all other District requirements, including water quality.

This memo is to provide technical information supporting that stormwater detention would have little to no discernable benefit on peak flood stages on the Minnesota River. This is due primarily to timing of the runoff from the project and from the larger watershed. Detention would delay the peak discharge to the river by less than one hour compared to the project without detention. Due to the short time of travel in the I-494 drainage system, the peak from I-494 will occur sooner than the peak from the larger river. Therefore, detention would tend to force the peak discharge from the system closer together in time to that of the river and potentially increase peak flows, as compared to the same project without detention. This and other supports for the resolution are provided in the following sections.

At the January 17, 2007 LMRWD Board Meeting, the Board made several requests of MnDOT, in addition to the information MnDOT intended to present; these requests (listed below) are addressed in Section 3 of this memorandum:

1. Reasons for why 2D is considered the least expensive project
2. What is the economic impact of doing the project without providing the detention pond
3. What is the daily fuels accumulation off the highway and what is the plan to protect the river
4. What is your spill response plan to protect the river at the last point before entering the river?
5. As high as possible sediment and phosphorus removal than 50% for water quality purposes
6. What are MnDOT's rules for volume control-runoff frequency relationships on new development?
7. Permanent reductions in groundwater
8. What is the quantity of water coming into the river and at what cfs?
9. What structures would be used to limit the surge and velocity of water into the river that may affect the active barge traffic
10. Draft language on a resolution

MnDOT's request is related primarily to the Alternative 1C, which includes a conveyance tunnel from Penn Avenue to the Minnesota River. The six Alternatives evaluated are described below:

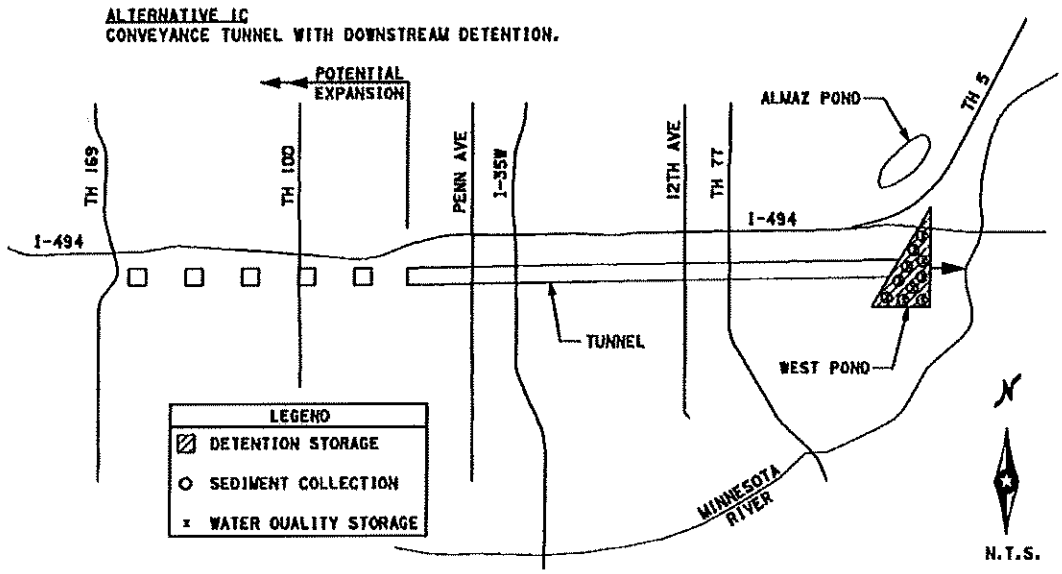
Alternative	Description	Estimated Cost (2005$)
1C – 10-ft Conveyance tunnel under I-494	Tunnel from Penn Ave. to Minnesota River outfall at West Pond site under I-494. Utilizes existing system and Almaz Pond. Water quality detention at West Pond	$105 M
2C – Existing Sewer with Modified Adjacent Ponding	Adjacent ponds provide both rate control and water quality detention.	$84 M
2D – Existing Sewer with Ponding Buried under Highway	Buried ponds provide rate control only; West Pond provides downstream water quality detention.	$60 M
2E – Existing Sewer with Modified Adjacent and Under Roadway Ponding	Buried ponds provide rate control only; West Pond provides downstream water quality detention.	$56 M
4A – Tunnel along I-35W with downstream water quality pond.	I-494 tunnel from 12th Ave S to Penn Avenue with outfall tunnel along I-35W to the Minnesota River. Utilizes existing system and Almaz Pond. Water quality detention near river.	$118 M
5A – 12-ft Storage Tunnel with Gravity Outfall	Tunnel is shorter than conveyance tunnel; drains by gravity by microtunnel to Minnesota River. Utilizes existing system and Almaz Pond. Rate control provided by tunnel; water quality detention at West Pond site.	$89 M

The cost estimates included not only initial construction costs, but the cost of maintenance, right-of-way, and the loss of local property tax revenue. The least cost alternative resulted when the existing storm sewer was reused, and detention storage was provided along the project route (Alternative 2). Alternatives 2D and 2C were least cost since they require less land acquisition due to the storage under the roadway and do not require a large tunnel as do Alternatives 1, 4 and 5. MnDOT's

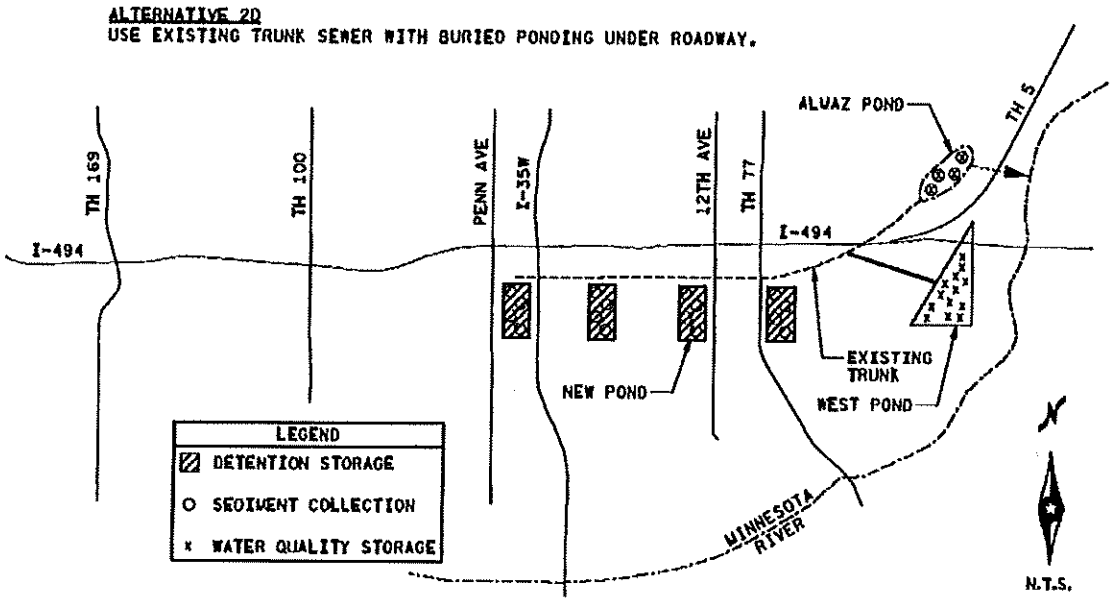
decision of preferred alternative will follow completion of the present investigation, which is to be completed by May 2007.

Alternatives 1C and 2D are depicted schematically below. (The ponds in Alternative 2D are indicative of the low point intersections which would require ponding for Alternatives 2C, 2D and 2E):

Alternative 1C – Conveyance Tunnel with Downstream Detention



Alternative 2D – Use Existing Sewer with Buried Ponding under Highway



2 Hydrologic and Hydraulic Analysis

Since the existing drainage system is under-capacity, surface flooding occurs for large storm events and limits the system discharge. Analysis of the existing system has shown that it surcharges for design events as small as the five-year, 24-hour rainfall. Once flooding is eliminated in the future project, the peak discharge will increase. However, for both the with- and without-detention conditions of Alternative 1C, most of the water volume from the project drains to the river within approximately six hours. Given the size and timing of flooding on the Minnesota River, it was undertaken to evaluate to what extent I-494 rate control would benefit the Minnesota River.

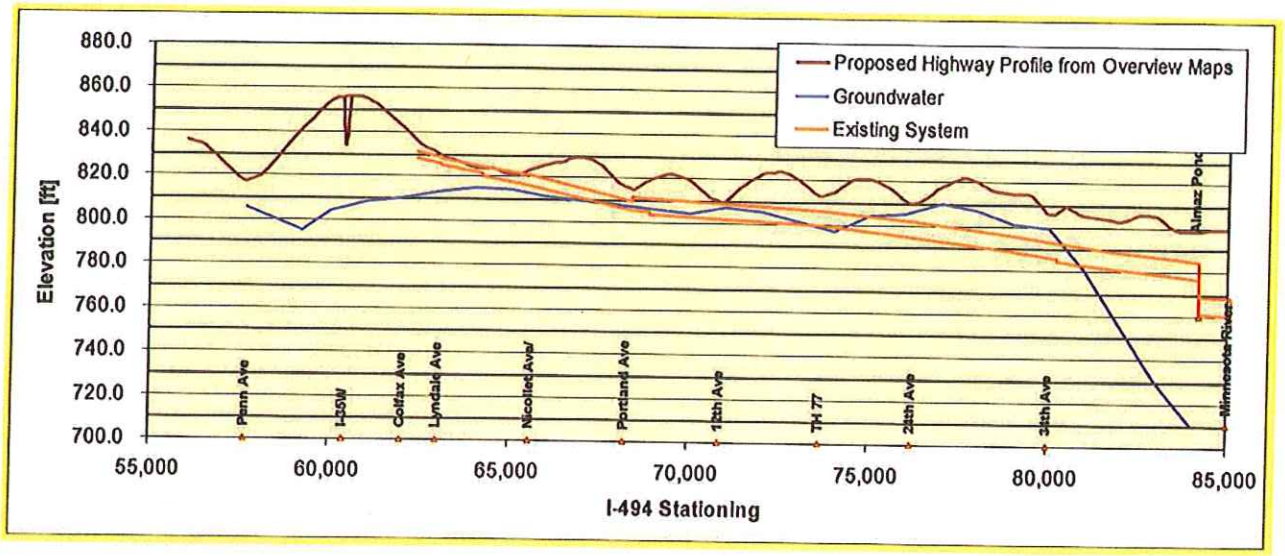
2.1 System Hydraulic Model

An XP-SWMM computer model was used to evaluate the hydraulic performance of alternative drainage systems for the I-494 Drainage Feasibility Study. XP-SWMM is the commercial version of the USEPA's Stormwater Management Model. It is a dynamic model which simulates rainfall runoff and performs hydraulic routing of discharge through pipe, pond and channel systems with free-surface and pressurized flow. Its advantage over simpler models is that it can simulate critical conditions (flooding and surcharging) when downstream pipe capacities are inadequate. A second advantage is that the runoff and hydraulic models are completed in a single simulation.

The model inputs describe the hydrologic characteristics of the watershed as well as the sizes, grades and capacities of conveyance system. The XP-SWMM model inputs (calculated according to the MnDOT Drainage Manual) are as summarized below:

Model Parameter	Value
Drainage Area	438 acres
Subwatersheds	38 Subwatersheds; Average size: 11.5 acres Range: 1.4 to 53 acres
SCS Curve Number	Average: 89 Range: 77 to 98
Subwatershed Time of Concentration	Average: 17 min Range: 7 to 48
Existing conveyance system	See profile below.
Rainfall amounts (24-hour, SCS Type II distribution)	50-year: 5.3 inches 100-year: 5.9 inches
Rainfall amount	10/4/2005: 4.89-inches
Almaz Pond	Area: 3.2 acres Volume: 19 ac-ft at El. 760

The existing trunk sewer system is depicted in the profile below:



Proposed I-494 Profile, Existing Trunk Sewer System Profile

Some of the pertinent results from the XP-SWMM modeling are described below:

2.2 Rate Control / Existing System Discharge Rates

LMRWD Design Considerations require that the peak rate of stormwater runoff from the future developed watershed or project shall not exceed the peak rate of runoff from the existing watershed or project. Thus rate control facilities would be required to limit the peak discharge from the proposed system.

An exemption to the rate control requirement would benefit the conveyance tunnel (Alternative 1C) by eliminating the requirement for downstream retention. The ponding alternatives (Alternative 2A through 2E) would not be affected since they require storage in order utilize the existing storm sewer discharge capacity; the discharge will be limited to less than the existing surcharged (flooded) capacities.

If an exemption cannot be acquired, the LMRWD will require that post-project peak runoff rates not exceed peak rates from the pre-project condition. The pre-project peak rates from the project would be limited to the existing peaks from the surcharged system (with surface flooding of low points). As a model of the existing I-494 corridor runoff was not available, the base model, with the post-project condition and the existing trunk sewer system was used to determine the existing peak discharge. The proposed conditions peak discharge is controlled by the existing trunk system capacity and surcharge elevation, not the runoff rate, during both the 50- and 100-year storms. Significant surface flooding and surcharging of the system act to store water and limit discharge. The evaluation showed that the peak discharge from the existing system under proposed conditions (including discharge from Almaz Pond and by-pass) to the Minnesota River was 433 cfs from the 50-year storm, and 467 cfs from the 100-year storm.

Without an exemption for the LMRWD rate control requirement, these will be the maximum discharge rates allowed from the future I-494 corridor. The higher peak discharge during the 100-year event is due to increased runoff and surcharging in the downstream portions of the system (i.e. International Drive to the River) which do not flood during either event. The peak discharge rates from the Alternative 1C tunnel with no detention would be 980 and 1,140 cfs for the 50- and 100-year events, respectively. Model results from the 100-year event and the storm that occurred on October 4, 2005 are shown below and in the Attachments to this memo:

100-yr Event	Merged Outflow Hydrograph (cfs)	Almaz Pond Peak Flow (cfs)	MN River Bypass Peak Flow (cfs)	Tunnel Peak Flow (cfs)	Total Runoff Volume (ac-ft)
Option 1C	1138	248	150	802	181
Option 1C w/detention	457	250	144	179	181

2.3 Relevant data from previous studies.

Wenck contacted the NWS and forwarded hydrographs for the project with and without detention storage. The NWS maintains a FLDWAV model of the Minnesota River that is used for predicting peak flood stages during flood events. NWS offered to simulate flows on the river for Alternative 1C with and without detention storage. However, due to the six-hour time step in the FLDWAV model, and since most of the flow leaves the system in six hours under both scenarios, the model could not resolve any difference due to storage. The FLDWAV model is built to model large flood events as they are occurring to make accurate predictions of peak flood stage. The six hour time step is appropriate since the hydrographs are substantially longer in time, most often several days or weeks in length.

2.4 Analysis of detention effects on Minnesota River for the October 4, 2005 large storm event.

The October 4, 2005 storm event was measured as nearly five inches the MSP Airport. It would have caused a large discharge from the proposed system. But the storm was small enough in areal extent that the time to peak on the Minnesota River was not very long. That is, the storm apparently affected the lowest portion of the river, not the entire watershed. Rainfall data from the MSP Airport were used with the XP-SWMM model to predict Alternative 1C discharge to the river both with and without detention storage. The discharge on the Minnesota River was taken from the USGS gauge near Fort Snelling.

The Minnesota River hydrograph was adjusted by first subtracting the modeled discharge from the existing system, then adding the discharge from Alternative 1C with and without detention. The input rainfall and Minnesota River discharge, and the future conditions results are shown on hydrographs in the Attachments. The modeled I-494 runoff volume from October 4, 2005 event was 140 ac-ft. By adding detention to the outfall, the peak discharge occurs about one hour later. Much of the detained volume is discharged later so that it actually coincides with the peak on the river. This slight increase of 40 cfs compared to without detention would cause an approximate 0.03 ft stage increase with detention, as determined from the DNR HECRAS model. These results are summarized below:

Minnesota River Hydrograph Info For October 4, 2005 storm	Peak Flow (cfs)	Increase in Stage* (ft)
Existing	20,056	--
Option 1C	20,050	--
Option 1C w/detention	20,091	0.03

* Stage Increase from HEC-RAS Cross Section Rating Curve

For larger storm and runoff events involving more of the watershed, it is anticipated that the peak from both with and without detention scenarios would precede the peak from the rest of the watershed. In either case, detention storage does not present a benefit to the Minnesota River in terms of lower peak stages.

2.5 Effect on 100-year flood stages on Minnesota River

Besides the NWS FLDWAV model, MnDNR maintained a HEC-2 model of this portion of the Lower Minnesota River. The HEC-2 model was recently updated with HECRAS with assistance from the US Army Corps of Engineers. The 100-year flood event (re-calculated in 2001) is 103,000 cfs. Effects noted below are based on the HECRAS model.

A rigorous analysis of the effect of I-494 rate control on the Minnesota River flood stages would be a prohibitively large effort. The HECRAS is a steady state model and cannot be used to evaluate the effects of rate control on I-494. As noted in Section 2.3, even tools for predicting flood stages are to coarse to detect the effect of the LMRWD rate control rule when applied to the I-494 drainage. Therefore, other measures where checked to develop a sense of the rate control effect.

The XP-SWMM analysis of the I-494 system shows that most of the volume from the 100-year event will reach the Minnesota River within approximately six hours of the precipitation event, with or without detention storage. Peak rates, with or without rate control, occur within one hour of the rainfall; and after about two hours, the project with rate control would cause higher flows. This means that detention and rate control will hold the water for just a short time, then release more at a time closer to peak on the river. When rainfall events occur over large portions of the Minnesota River basin, the main peak on the river is delayed by travel time. Three such events on the Minnesota River showed a delay of about six days between the peaks at the USGS gauges at Montevideo and Savage. Thus, the discharge from I-494 would have no effect on the peak flood stage.

3 Answers to LMRWD Manager Questions

The questions listed in the minutes of the January 17, 2006 meeting are answered in the following paragraphs:

Question 1. Reasons for why 2D (2C) is considered the least expensive project.
Answer: See Alternatives table under Introduction. During the study process, we examined the estimated costs of each of six alternatives. The estimates included not only initial construction costs, but the cost of maintenance, right-of-way, and the loss of local property tax revenue. The least cost alternative resulted when the existing storm sewer was reused, and detention storage was provided along the project route (Alternative 2). Alternatives 2D and 2C were least cost since they require less land acquisition than 2C due to the storage under the roadway and do not require a large tunnel as do Alternatives 1, 4 and 5.

Question 2. What is the economic impact of doing the project without providing the detention pond
Answer: The highest cost of the alternatives considered was for the tunnel schemes. However, the selection of any alternative will ultimately be based upon both cost and other factors. The tunnel alternative (Alternative 1) cost estimate includes roughly $1.5M for work at and about West Pond. This provided for construction of both dead and live storage for both water quality and stormwater detention purposes. Our current estimate does not calculate the incremental project cost of eliminating detention storage. However, this cost would not exceed $1.5M, or approximately 1-2% of the overall project cost.

The impact is more of practicality since a rate control pond would require embankments (dams) placed above the existing grade and would block floodplain storage volume as well as reducing conveyance of the flood plain directly under the I-494 bridge over the river. Also, MnDOT soil borings and foundation analysis for the present maintenance work at West Pond indicate that it would be infeasible to construct dikes (or place dredge spoils) on the site due to the soft soil conditions.

Question 3. What is the daily fuel accumulation of the highway? What is plan to protect the river?
Answer: Small amounts of hydrocarbons from vehicle fuel leaks or exhaust would normally volatilize to the atmosphere and are not expected to significantly accumulate on the road surface or in stormwater runoff. Accumulated pollutants from wear on vehicles and brake pads normally include some metals. The design of each alternative will include water quality detention according to LMRWD Design Considerations (NURP Standard) which is normally accepted as effective treatment for metals from stormwater.

Question 4. What is your spill response plan to protect river at last point before entering the river?
Answer: MnDOT spill response is detailed in the attached *MnDOT Policy Position Statement on Emergency Operations for Hazardous Materials Spills;* and the *MnDOT Maintenance Bulletin Number 97-1, Roadway Accident Scene Vehicle Fluid Spill Response Procedure*. The intent of these policies and practices is to contain spill materials and minimize their transport into waters. Presently the West Pond outlet has a valve on the outlet which can be closed in response to a spill on the system to contain buoyant, hydrophobic liquids. West Pond would be enlarged and reconstructed under Alternatives 1C, 2D, 2E and 5A in order to provide water quality detention. The outlet from the pond to the river would include either a skimmer that would help detain buoyant liquids or a two-staged discharge with a valved low flow outlet which would be closed in the event of a spill.

Question 5. As high as possible sediment / phosphorus removal than 50% for water quality purposes
Answer: The Minnesota River is classified as a Level II/Level III Water Resource within the LMRWD Classifications. This results in a requirement of water quality detention ponds with specific design requirements as listed in Section 5.13.3 of the LMRWD Watershed Management Plan. The LMRWD Design Considerations require that the permanent pool volume below the normal outlet be at least equal to the runoff from a 2.5 inch, 24-hour storm over the entire subwatershed. This is equivalent to NURP standards where the aim is to develop an average residence time of about 16 days and remove approximately 50 percent of inflow

phosphorus. (In the NURP design calculations volume is actually larger than required; the calculations consider that 20 percent of the volume is unavailable due to sediment accumulation, i.e., runoff from the 2.0-inch storm would be sufficient to give 50 percent removal.)

The XP-SWMM model was used to determine the dead volume requirement for a regional water quality pond. The dead volume requirement by MPCA (1999) for a pond discharging to a Level II water resource is equal to runoff from a 2.5-inch, 24-hour storm over the entire subwatershed, or over the entire project site for the on-site basins. For this project, the volume of runoff from this event is 52 acre-feet. This is the volume that would be required for a single pond treating runoff from the entire drainage area.

The water quality ponds are sized according to LMRWD (and NURP) standards with the dead volume equal to runoff from the 2.5-inch, 24-hour storm. However, in some alternatives, water flows through both the low point ponds and through the existing Almaz Pond (19 acre-feet). In these cases of ponds in series, the phosphorus removal was estimated using the PondNet model (Walker), which is the basis for the NURP performance criteria. Pond dead volumes were adjusted according to a total removal of 50 percent.

MnDOT will follow the LMRWD Design Considerations which are based on runoff volume from the 2.5-inch, 24-hour storm (NURP standard), or its equivalent of 50 percent phosphorus removal with 20 percent of dead volume occupied by sediment.

Question 6. What are MnDOT's rules for volume control-runoff frequency on new development?
Answer: MnDOT has been operating under its MS4 permit since 2003 and is not presently required to control runoff volume.

Regarding magnitude or frequency of the design storm, Manager Samstad suggested MnDOT consider larger design storms; he suggested that the TP40 values have been exceeded much more frequently than the analysis would suggest. MnDOT will design according to TP-40, unless that standard is replaced. Increased frequency of large events should not affect the project performance. It should be noted that the project is being designed to an unusually high standard for highway drainage systems. Due to the several low points at bridges along the system which can only drain through the trunk sewer, the standard has been set to 1) No surcharging of pipe or tunnel conduits at the 50-year rainfall event; and 2) No surface flooding during the 100-year rainfall event.

Question 7. Permanent reductions in groundwater
Answer: The tunnel would be designed to be water tight and therefore not affect groundwater levels in the area. Ponds would be designed with runouts at the water table elevation. The presence of groundwater in sandy soils along the site necessitates the use of a pressurized cutting head on the tunnel boring machine (earth pressure balance method). This ensures that the interior of the tunnel remains dry during construction. Once complete, the tunnel will be watertight with a gasketed, segmental reinforced-concrete lining. As such, it would have little to no effect on local groundwater levels.

Question 8. What is the quantity of water coming into the river and at what cfs?
Answer: See Section 2 and Attachments.

Question 9. What structures would be used to limit the surge and velocity of water into the river that may affect the active barge traffic

Answer: Energy dissipation structures would be incorporated into the outlet from the tunnel to the West Pond water quality pond (both with and without rate control). The pond would be designed in a two-cell arrangement with the first smaller cell to allow further energy dissipation before flowing into the second cell. (The volume of the first cell would be considered ineffective in determining the required water quality storage volume.) This would improve the settling characteristics of the second cell.

The overflow from the pond to the river would likely be over a weir designed to cause low exit velocities and reduce the potential of a surface jet or current crossing the river and affecting barge traffic. Discharge volume and rate through the Almaz Pond outfall will decrease as a result of the project.

Question 10. Draft language on a resolution

Answer: Provided separately.

4 Summary

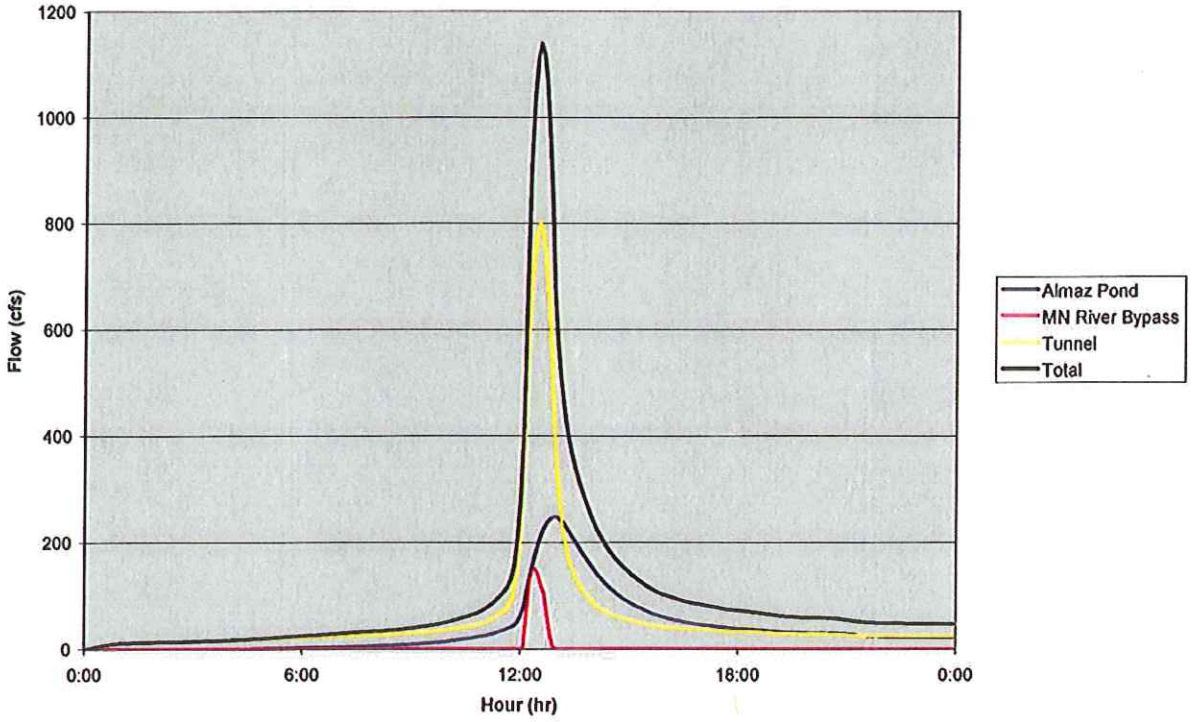
A decision to support or allow Alternative 1C to be planned without detention for rate control is supported by the following points:

1. The existing drainage system on I-494 from Penn Avenue to the Minnesota River is undersized and is prone to flooding at events as small as the five-year rainfall. This would result in low-point flooding at several bridge underpasses, which presently restricts peak discharge rates from the system.
2. Whether the project is constructed with or without rate control, MnDOT will meet the present water quality requirements of the LMRWD. This would require a water quality pond at West Pond, which could be constructed without decreasing the Minnesota River flood plain storage or conveyance on the flood plain.
3. Hydraulic analysis of the 494 system shows that most of the volume from the 100-year event will reach the Minnesota River within approximately six hours of the precipitation event, with or without detention storage. Peak rates occur within one hour of the rainfall and after about two hours, the project with detention would cause higher flows. This means that detention and rate control will tend to hold the water a short time, but release more of at the time of the peak on the river.
4. Comparison of modeled project discharges from the October 4, 2005 storm show that rate control on the I-494 project would not reduce the peak flow on the river, but tend toward increases. In events producing large floods on the Minnesota River, the time between the I-494 peak and the river peak will be larger.
5. Construction of a rate control pond at the West Pond site would require dikes placed around the facility in order to detain the water volume. MnDOT soil borings and foundation analysis for the present maintenance work at West Pond indicate that it would be infeasible to construct dikes (or place dredge spoils) on the site due to the soft soil conditions.
6. Furthermore, dikes around the detention pond would have to be built above the surrounding topography and would block floodplain conveyance directly under the I-494 bridge constriction.
7. The outlet of the West Pond water quality pond would be designed to minimize the potential for spilled liquids to enter the Minnesota River from the project.
8. MnDOT has addressed, or will address, in design, the other concerns raised by the LMRWD Managers.

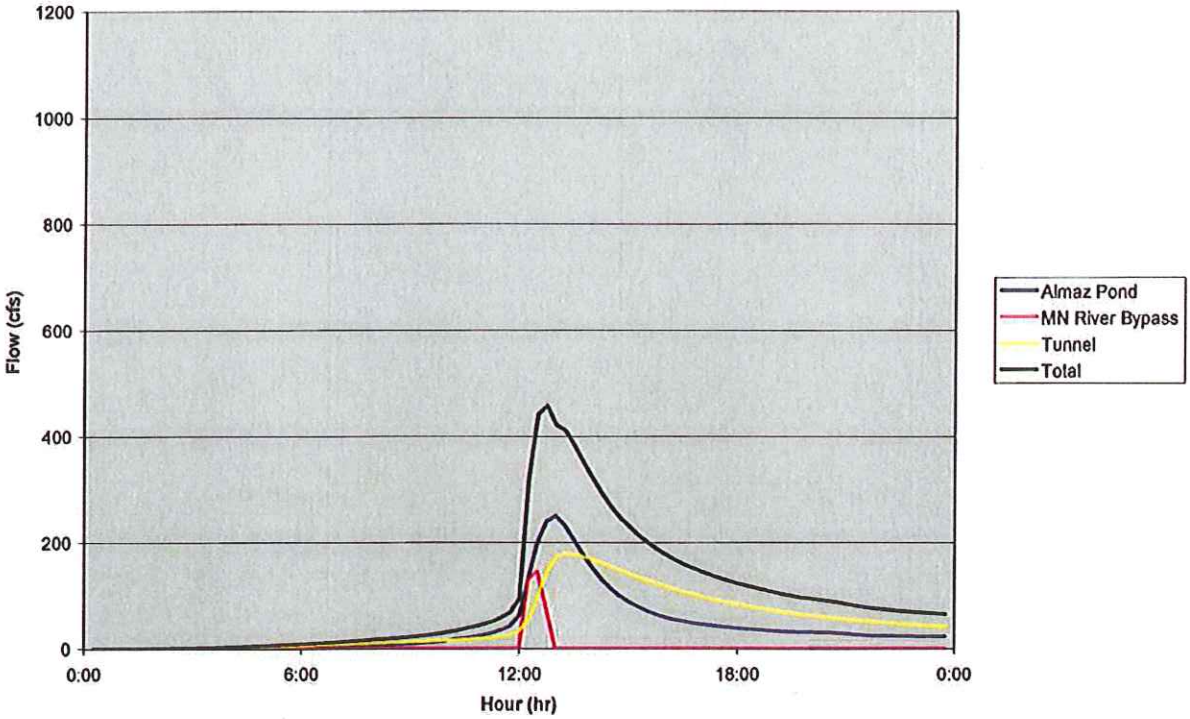
5 Attachments:

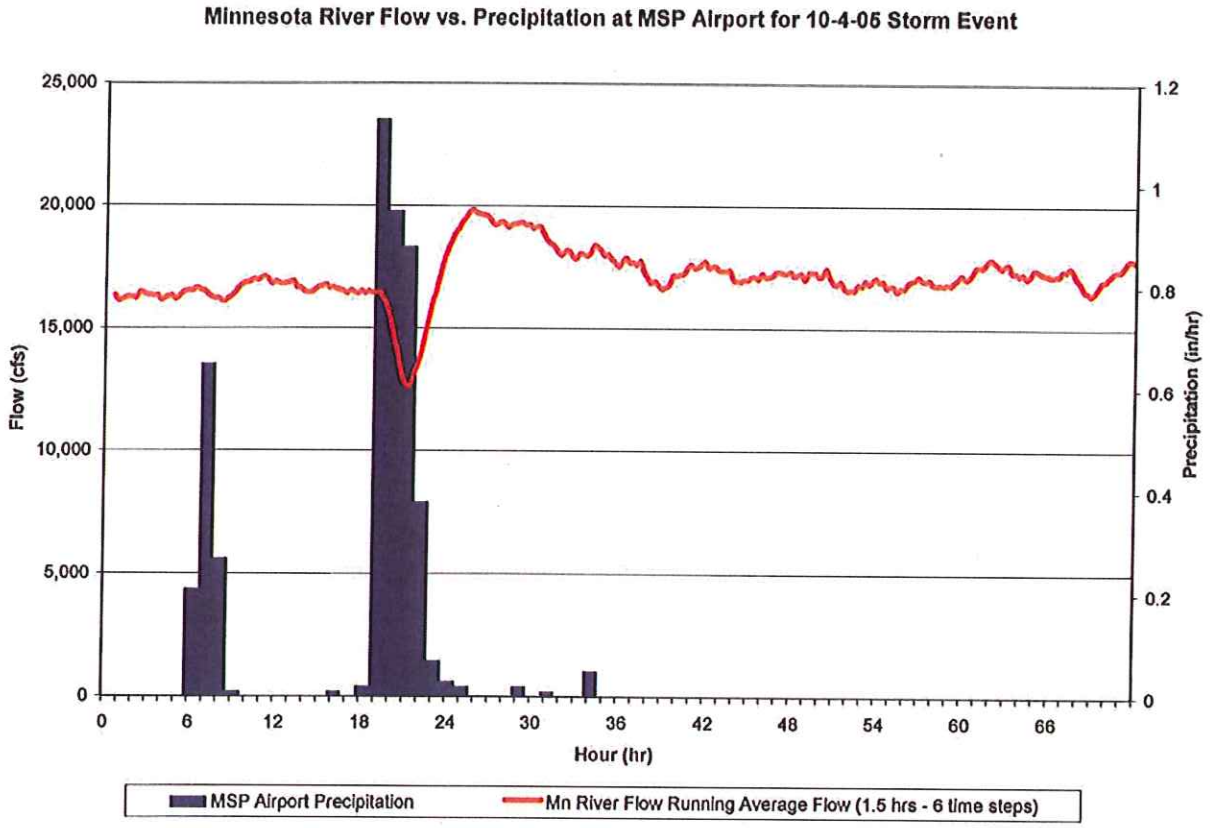
- Alternative 1C 100-year Event XP-SWMM Output Hydrographs, without and with detention
- Minnesota River Flow (USGS Gauge at Fort Snelling) and Precipitation at MSP Airport for October 4, 2005 Storm
- Alternative 1C October 4, 2005 Event XP-SWMM Output Hydrographs, without and with detention
- Alternative 1C October 4, 2005 Event XP-SWMM Output Hydrographs, without and with detention, incremental flow difference;
  USGS – Fort Snelling Gauge with Alternative 1C (without and with detention) flow increment added to existing conditions hydrograph
- Air Photo Plates 2, 3, and 4 from Floodplain Areas of the Lower Minnesota River, prepared by the U.S. Army Corps of Engineers and the U.S. Geological Survey in 2004.
- MnDOT Policy Position Statement, June 16, 1989, Multimodal No. 89-1 Emergency Operations; Hazardous Materials Spills, Abandonment
- MnDOT Maintenance Bulletin Number 97-1, January 31, 1997, Roadway Accident Scene Vehicle Fluid Spill Response Procedure
- Photograph of existing valve at West Pond outlet.

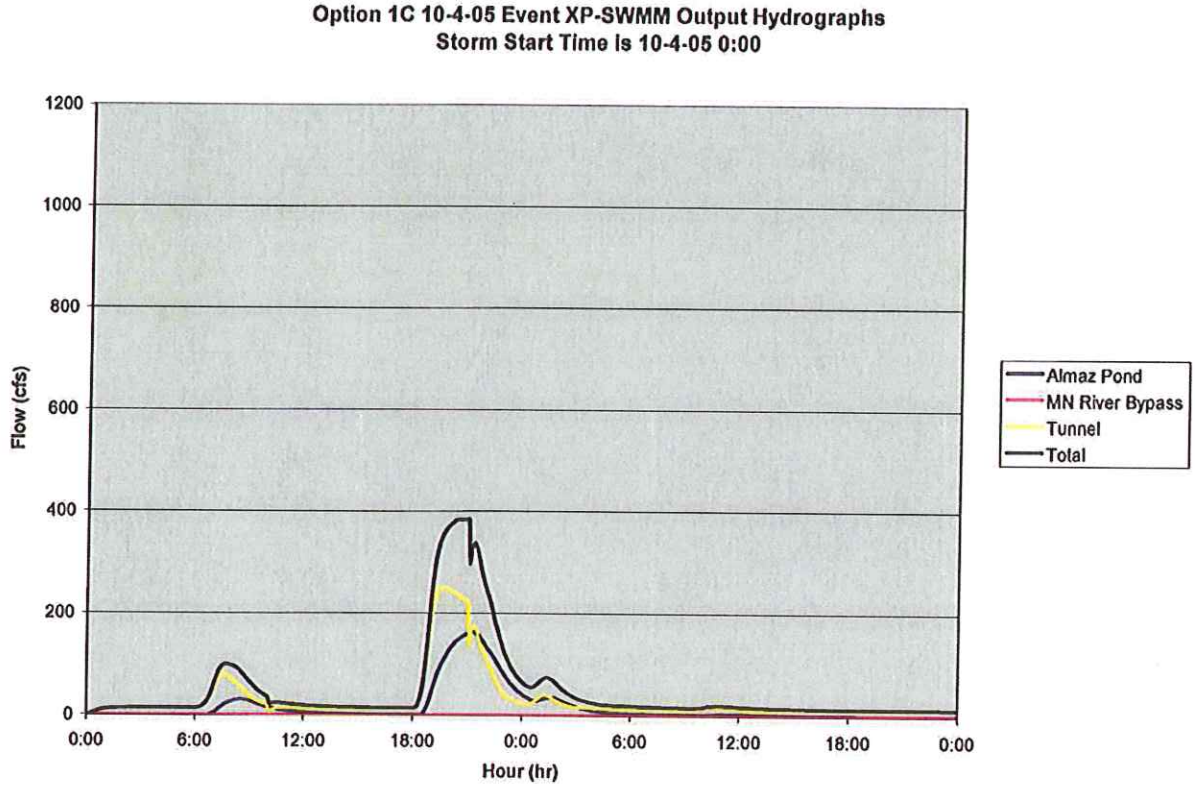
Option 1C 100-year Event XP-SWMM Output Hydrographs

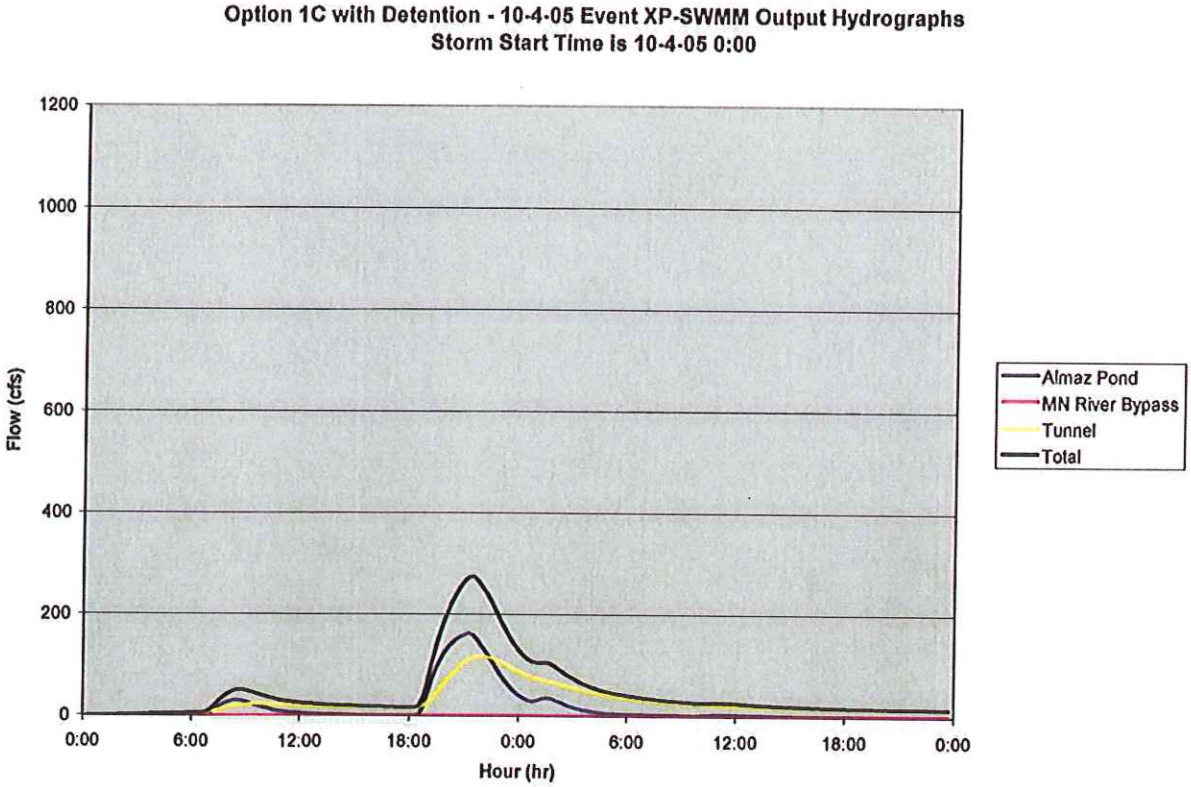


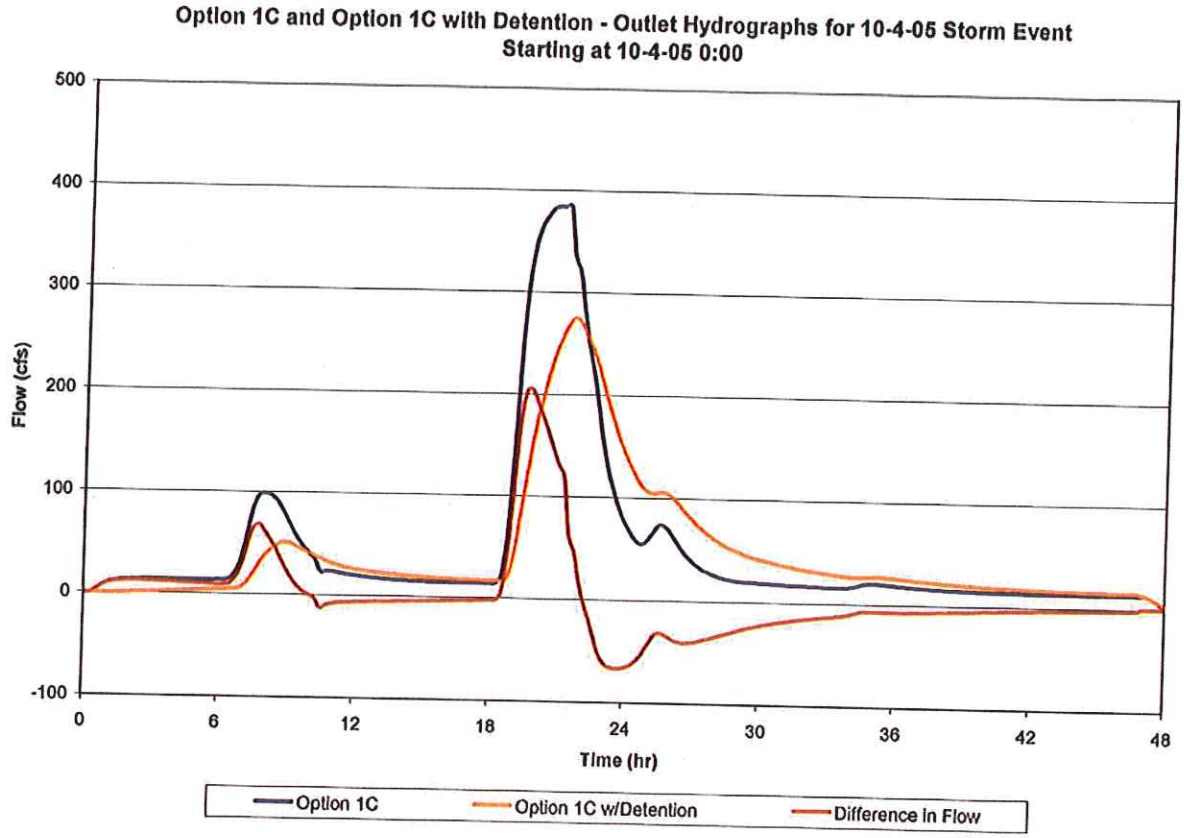
Option 1C with Detention 100-year Event XP-SWMM Output Hydrographs

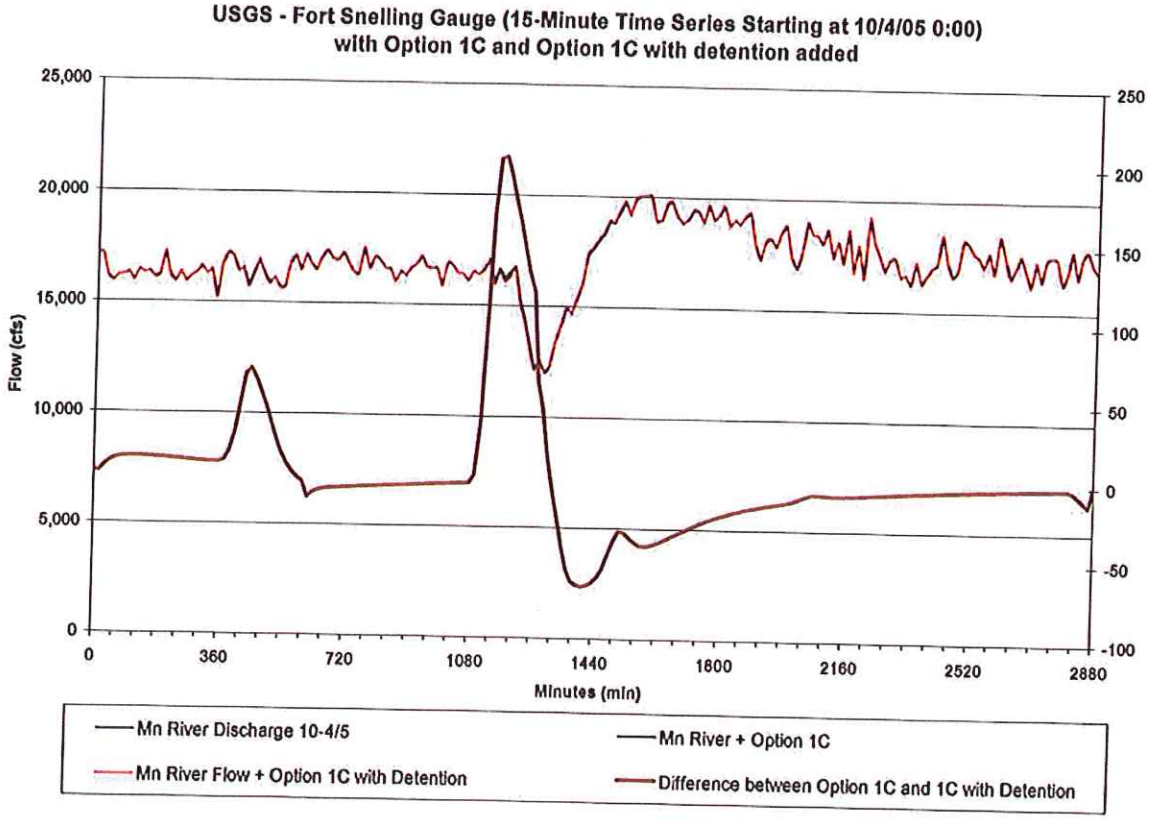



Minnesota River Flow vs. Precipitation at MSP Airport for 10-4-05 Storm Event
25,000
20,000
15,000
10,000
5,000
0
Flow (cfs)
1.2
1
0.8
0.6
0.4
0.2
0
Precipitation (in/hr)
0
6
12
18
24
30
36
42
48
54
60
66
Hour (hr)
MSP Airport Precipitation
Mn River Flow Running Average Flow (1.5 hrs - 6 time steps)


Option 1C 10-4-05 Event XP-SWMM Output Hydrographs
Storm Start Time is 10-4-05 0:00
Flow (cfs)
1200
1000
800
600
400
200
0
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
Hour (hr)
Almaz Pond
MN River Bypass
Tunnel
Total


Option 1C with Detention - 10-4-05 Event XP-SWMM Output Hydrographs
Storm Start Time is 10-4-05 0:00
Flow (cfs)
1200
1000
800
600
400
200
0
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
Hour (hr)
Almaz Pond
MN River Bypass
Tunnel
Total


Option 1C and Option 1C with Detention - Outlet Hydrographs for 10-4-05 Storm Event
Starting at 10-4-05 0:00
Flow (cfs)
500
400
300
200
100
0
-100
0
6
12
18
24
30
36
42
48
Time (hr)
Option 1C
Option 1C w/Detention
Difference in Flow


USGS - Fort Snelling Gauge (15-Minute Time Series Starting at 10/4/05 0:00)
with Option 1C and Option 1C with detention added
Flow (cfs)
25,000
20,000
15,000
10,000
5,000
0
250
200
150
100
50
0
-50
-100
0
360
720
1080
1440
1800
2160
2520
2880
Minutes (min)
Mn River Discharge 10-4/5
Mn River + Option 1C
Mn River Flow + Option 1C with Detention
Difference between Option 1C and 1C with Detention

Lower Minnesota River Watershed District

Len Kremer, President
Hennepin County
Ron Kraemer, Vice President
Dakota County
Lawrence Samstad, Manager
Scott County

Kent Francis, Secretary
Carver County
Edward A. Schlampp, Treasurer
Hennepin County
Terry L. Schwalbe, Administrator
Cell (952) 221-1089

LOWER MINNESOTA RIVER WATERSHED DISTRICT

DRAFT RESOLUTION NO. 2007-01

Interstate Highway 494 – Penn Avenue to Minnesota River

WHEREAS, the Minnesota Department of Transportation (MnDOT) is studying stormwater drainage alternatives for the portion I-494 from the Penn Avenue low point to the Minnesota River, and has provided information about the alternatives and their effect on the Minnesota River to the Board of Managers and has requested a determination that their Alternative 1C be determined to be eligible for exemption from the District's rate control requirement as documented in a technical memorandum *(Subject: MnDOT – I-494 Stormwater Alternatives Study (Penn Avenue to Minnesota River) Technical support for resolution by Lower Minnesota River Watershed District Board regarding rate control requirements)* dated February 2007 and presented to the Managers at their February 21, 2007 meeting; and

WHEREAS, the existing I-494 drainage system is undersized for present and future conditions; and

WHEREAS, the I-494 drainage investigation is being undertaken as part of long-term planning for a future roadway expansion project and MnDOT is not applying for a LMRWD permit at this time; and

WHEREAS, MnDOT has addressed questions raised by the LMRWD Board of Managers; and

WHEREAS, the information presented to the Board supports a finding that requiring rate control for Alternative 1C would not have a beneficial effect on Minnesota River flood stages, and a rate control pond would displace existing floodplain storage volume and reduce river conveyance; and

WHEREAS, the soils at the West Pond site are poor and incapable of supporting the dike structures necessary to construct a rate control pond; and

1600 Bavaria Road, Chaska, MN 55318
Terry Schwalbe: 952-227-1037; Joan Ellis: 952-227-1038; Fax: 952-227-1039
E-mail terrys@lowermn.com; joane@lowermn.com

WHEREAS, the request by MnDOT is limited to this I-494 drainage project, and MnDOT will meet other LMRWD Design Considerations including water quality.

NOW THEREFORE BE IT RESOLVED, the LMRWD Board of Managers conceptually agree at this point in time with the Minnesota Department of Transportation that the Alternative 1C, as will be further developed in the study, could be permitted in the future without meeting rate control requirements of the LMRWD Design Considerations; and

BE IT FURTHER RESOLVED, the above determination that the Alternative 1C could be permitted without meeting rate control requirements of the LMRWD Design Considerations is made under the current regulatory conditions affecting the LMRWD and MnDOT, that a future Board may decide not to permit the project, and this resolution would not be binding on a future Board during the future permitting of the project, nor would it exempt any future regulations or future LMRWD Rules; and

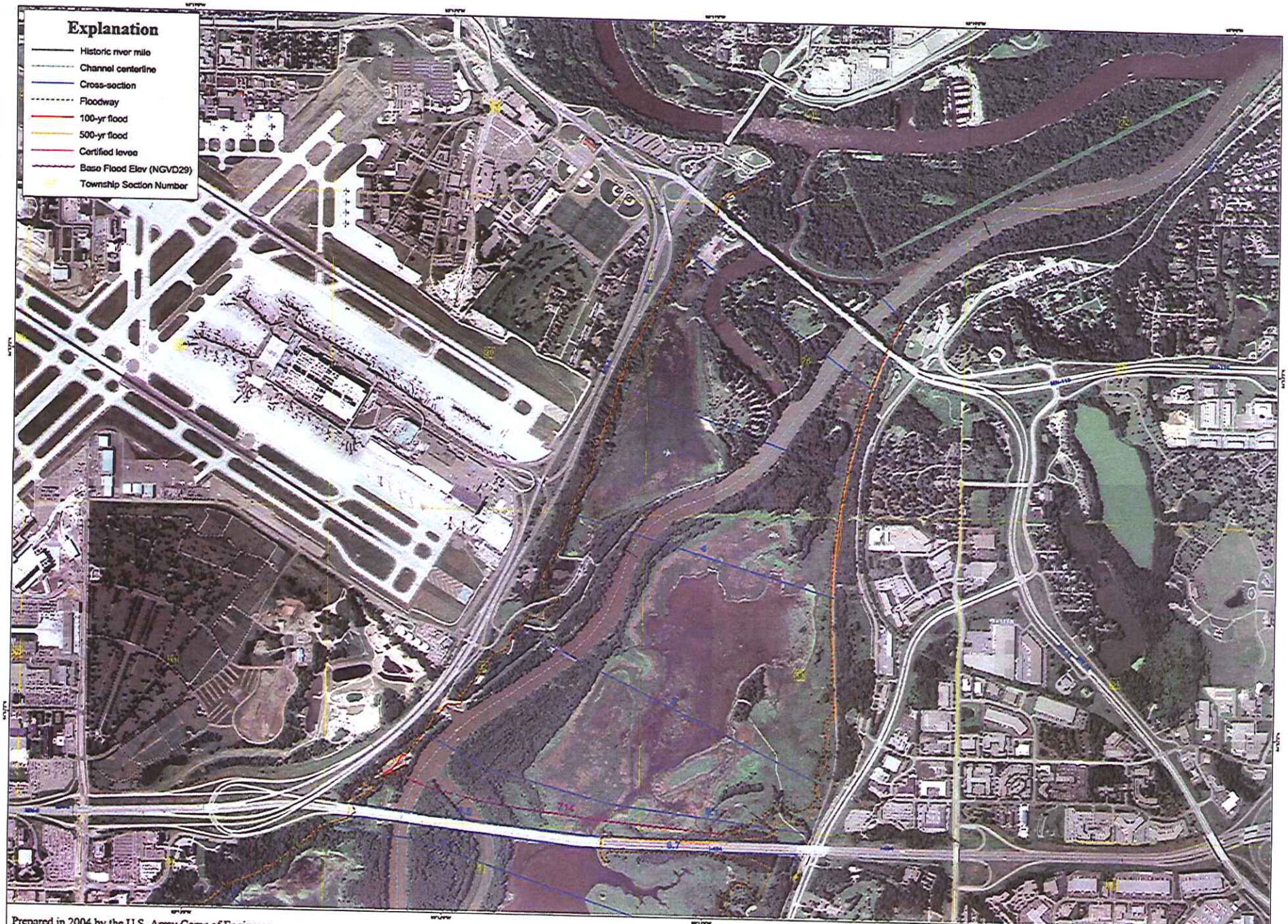
BE IT FURTHER RESOLVED, the I-494 drainage system from Penn Avenue to the Minnesota should be designed to meet all other LMRWD Design Considerations.

Adopted: _____

LOWER MINNESOTA RIVER WATERSHED DISTRICT

By: _____
Len Kremer, President

1600 Bavaria Road, Chaska, MN 55318
Terry Schwalbe: 952-227-1037; Joan Ellis: 952-227-1038; Fax: 952-227-1039
E-mail terrys@lowermn.com; joane@lowermn.com



Prepared in 2004 by the U.S. Army Corps of Engineers and the U.S. Geological Survey in Cooperation with the Lower Minnesota River Watershed District and the Minnesota Department of Natural Resources

1 inch equals 500 feet

0 500 1,000 2,000 3,000 Feet

FLOOD PLAIN AREAS OF THE LOWER MINNESOTA RIVER

Photobase - 2003 USDA - Farm Service Agency Orthophoto

PLATE 2

Prepared in 2004 by the U.S. Army Corps of Engineers and the U.S. Geological Survey in Cooperation with the Lower Minnesota River Watershed District and the Minnesota Department of Natural Resources

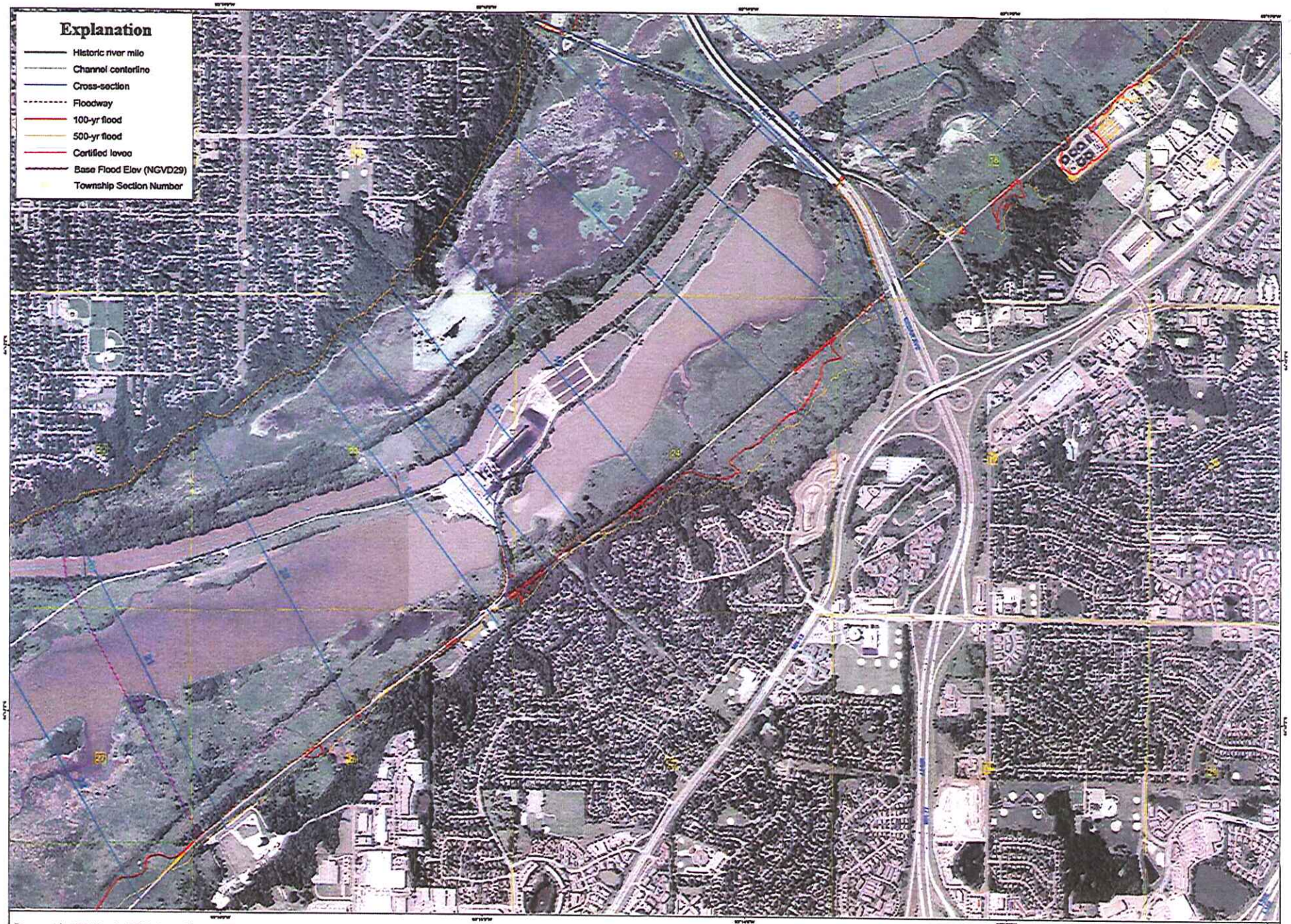
1 inch equals 500 feet

0 500 1,000 2,000 3,000 Feet

FLOOD PLAIN AREAS OF THE LOWER MINNESOTA RIVER

Photobase - 2003 USDA - Farm Service Agency Orthophoto

PLATE 3



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1 inch equals 500 feet

0 500 1,000 2,000 3,000 Feet

FLOOD PLAIN AREAS OF THE LOWER MINNESOTA RIVER

Photobase - 2003 USDA - Farm Service Agency Orthophoto

Lower Minnesota River Watershed District

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Lawrence Samstad, Manager
Hennepin County
Terry L. Schwalbe, Administrator
Cell (952) 221-1089

February 21, 2007

Mr. John R. Thene P.E.
Wenck Associate, Inc.
1800 Pioneer Creek Center
P.O. Box 249
Maple Plain, MN 55359-0249

Re: I-494 Drainage Alternatives Analysis

Dear Mr. Thene

Manager Samstad requests you address the following concerns at the March 21, 2007 Board of Managers meeting:

a. MNDOT **must** update the frequency curves for Minnesota before further consideration by Manager of District. **LONG OVERDUE!!! DATA IS AVAILABLE!!!! AND HAS BEEN FOR SOME TIME.**

b. Are there any changes in Wright Pond or Smith Pond watersheds (Bloomington)? Have parts of these watersheds been added to the proposed I 494 drainage systems?

c. What will the final outlet (channel, sluice, or pipe) capacity be at the outfall before entering the Minnesota River? If used will pipe be secured properly to avoid surge or water-hammer conditions?

d. Will there be a ponding area within the LMRWD? If so- size, location, outlet?

e. How does the final outlet affect the current in the Minnesota River and will it be a hazard to tow boats and private water craft?

Sincerely,

Terry L. Schwalbe
Administrator

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1800 Pioneer Creek Ctr.
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Maple Plain, MN 55359-0249

(763) 479-4200
Fax (763) 479-4242
E-mail: wenckmp@wenck.com

TECHNICAL MEMORANDUM

TO: Alan Palmer, P.E., Transportation Engineer, Stanley Consultants, Inc.
Beth Neuendorf, P.E., Metro District Water Resources Engineer, MnDOT

FROM: Chris Meehan, PE and John Thene, PE

DATE: March 15, 2007

SUBJECT: MnDOT – I-494 Stormwater Alternatives Study (Penn Avenue to Minnesota River)
Lower Minnesota River Watershed District - Manager Samstad Questions

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This memo is to address concerns raised submitted to Wenck on March 9 from Manager Samstad following our presentation at the February 21, 2007 LMRWD Board of Managers meeting.

Information to address these and other concerns was provided in a Wenck memorandum and presentation made at the February 21 board meeting. I would like to emphasize that the level of hydraulic design is not detailed and that some of the concerns will first be directly addressed in Final Design.

The concerns raised are quoted and addressed below:

a. MNDOT **must** update the frequency curves for Minnesota before further consideration by Manager of District. **LONG OVERDUE!!! DATA IS AVAILABLE!!!! AND HAS BEEN FOR SOME TIME.**

> Answer: This concern is in fact well-recognized in the water resources field. It is likely that TP-40 will be updated or replaced in the years between now and the final design of the I-494 drainage. As mentioned in the February 21 memo and meeting, MnDOT will design to the accepted design storms at the time of final design and permitting.

b. Are there any changes in Wright Pond or Smith Pond watersheds (Bloomington)? Have parts of these watersheds been added to the proposed I 494 drainage systems?

> Answer: There are no changes to Wright or Smith Ponds associated with the I-494 drainage alternatives study. The I-494 system design is based on the existing drainage areas.

c. What will the final outlet (channel, sluice, or pipe) capacity be at the outfall before entering the Minnesota River? If used will pipe be secured properly to avoid surge or water-hammer conditions?

Answer: The simulated 100-year peak discharge from the tunnel system would be 800 cfs. The final arrangement of the outfall would be determined in final design in order to minimize impacts to barge traffic. It is likely that the West Pond outlet would include a channel connecting the outlet weir to the river in order to reduce velocities and cross-currents in the river. (See also Concern *e* below.) Any outfall pipe to the river would be constructed with mechanically or otherwise connected segments.

d. Will there be a ponding area within the LMRWD? If so- size, location, outlet?

Answer: Regarding Alternative 1C, the subject of the proposed resolution, the dead volume of West Pond would be expanded for water quality treatment. The tunnel discharge volumes to the pond are documented in the February 21, 2007 memo.

e. How does the final outlet affect the current in the Minnesota River and will it be a hazard to tow boats and private water craft?

Answer: MnDOT is aware of the potential affects of stormwater outfalls on barge navigation. This was addressed in the February 21, 2007 memo in the answer to Question 9 (quoted below) and would be further addressed in final design.

Energy dissipation structures would be incorporated into the outlet from the tunnel to the West Pond water quality pond (both with and without rate control). The pond would be designed in a two-cell arrangement with the first smaller cell to allow further energy dissipation before flowing into the second cell. (The volume of the first cell would be considered ineffective in determining the required water quality storage volume.) This would improve the settling characteristics of the second cell.

*The overflow from the pond to the river would likely be over a weir designed to cause low exit velocities and reduce the potential of a surface jet or current crossing the river and affecting barge traffic. Discharge volume and rate th*rough the Almaz Pond outfall will decrease as a result of the project.

Memo appended to Board Resolution by vote of Board

March 21, 2007

Fax to Alan Palmer
952-546-4279

MEMO

To: LMRWD Board of Managers, Staff

From: Lawrence Samstad, P.E., Scott County Manager

Re: MnDOT – I 494 Stormwater Alternatives Study

In reviewing Mr. John Thene's PE replies to my questions forwarded to him by Terry Schwalbe, I find that the answers are not as clear and definitive as they should be considering that MnDOT wants the Managers to sign an agreement for only a portion of the above study. The proposed agreement amounts to a 'carte blanche' where the final results of the study may not be in the best interests of the Lower Minnesota River Watershed District. May I take the opportunity to review the responses by lettered questions and the responses from Mr. Thene.

A. Technical Paper 40 was derived of sparse information acquired by the U.S. Weather Bureau in the 30's, 40's and 50's. Since then, more detailed information has been acquired by the U.S. Weather Bureau in conjunction with local information from reliable sources. A portion of that information was released in a report "Sixteen Year Study of Minnesotta Flash Floods – January 1988". Since 1988 (almost 20 years later) no revision has been made to the MnDOT chart of flooding frequencies. Even though T.P. 40 clearly states the for any given frequency, one must have two and one half times that frequency in record to support the results of that frequency result (rainfall amount and rainfall intensity maximas.) In the 18 years of the study 59 storms have equaled or exceeded the 100 year event in the State of Minnesota. A good reason for revising MnDOT's graph on frequency. A graph which has been used for the last 40 to 50 years by Engineers and Weathermen alike. The point is – isn't it about time to come out of the "Dark Ages" of improper frequency relationships? Why do we need to wait for the I-494 study to complicate this "fiction" further?

Small scale. Should be so.

B. The question was not whether the Smith or Wright Ponds were changed, but rather were the watersheds of these ponds (in whole or in part) made a part of the I-494 study? If so, how much? The answer is unclear and seems to be hedging as to whether those former watersheds will be a part of the I-494 study. ONLY IF THEY ARE IN THE 494 DRAINAGE. // Blooming ponds not ask Van help.

C. Again, to use the 100 year frequency peak discharge is to use a discharge that is not supported by 250 years of frequency record. What fictitious figure will be used for this calculation?

Used 5.9 inches from TP-40

D. The answer does not describe the size, location or outlet of any proposed pond. Considering the limited space in this area according to recent negotiations with MnDOT on dredge material sites, isn't this a pertinent question at this point?

Approx. Dead Volume 90-acre ft
Size ~ 16 acres

E. Areas will be required to accommodate an energy dissipator as well as a pond. Where does this space exist?

Sells
It does. May be built into bluff

Based on the equivocation in the answers of Mr. Thene, and based on my knowledge of the District's desires I respectfully request the Board of Managers withhold their signatures on the proposed contract with MnDOT until significant answers are forthcoming without evasion and/or hedging.

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Maple Plain, MN 55359-0240

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E-mail: wenckmp@wenck.com

Wenck

TECHNICAL MEMORANDUM

TO: Alan Palmer, P.E., Transportation Engineer, Stanley Consultants, Inc.
Beth Neuendorf, P.E., Metro District Water Resources Engineer, MnDOT

FROM: Chris Meehan, PE and John Thene, PE

DATE: February 21, 2007

SUBJECT: MnDOT – I-494 Stormwater Alternatives Study (Penn Avenue to Minnesota River)
Lower Minnesota River Watershed District - Manager Samstad Questions

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This memo is to address concerns raised submitted to Wenck on March 9 from Manager Samstad following our presentation at the February 21, 2007 LMRWD Board of Managers meeting.

Information to address these and other concerns was provided in a Wenck memorandum and presentation made at the February 21 board meeting. I would like to emphasize that the level of hydraulic design is detailed enough for preliminary design purposes and that refinements will be made to the level of detail during the final design stages of the project.

The concerns raised are quoted and addressed below:

A a. MNDOT must update the frequency curves for Minnesota before further consideration by Manager of District. LONG OVERDUE!!! DATA IS AVAILABLE!!! AND HAS BEEN FOR SOME TIME.

Answer: This concern is in fact well-recognized in the water resources field. It is likely that TP-40 will be updated or replaced in the years between now and the final design of the I-494 drainage. As mentioned in the February 21 memo and meeting, MnDOT will design to the accepted design storms at the time of final design and permitting.

B b. Are there any changes in Wright Pond or Smith Pond watersheds (Bloomington)? Have parts of these watersheds been added to the proposed I 494 drainage systems?

Answer: There are no changes to Wright or Smith Ponds associated with the I-494 drainage alternatives study. The I-494 system design is based on the existing drainage areas.

C – c. What will the final outlet (channel, sluice, or pipe) capacity be at the outfall before entering the Minnesota River? If used will pipe be secured properly to avoid surge or water-hammer conditions?

Answer: The simulated 100-year peak discharge from the tunnel system would be 800 cfs. The final arrangement of the outfall would be determined in final design in order to minimize impacts to barge traffic. It is likely that the West Pond outlet would include a channel connecting the outlet weir to the river in order to reduce velocities and cross-currents in the river. (See also Concern e below.) Any outfall pipe to the river would be constructed with mechanically or otherwise connected segments.

D – d. Will there be a ponding area within the LMRWD? If so- size, location, outlet?

Answer: Regarding Alternative 1C, the subject of the proposed resolution, the dead volume of West Pond would be expanded for water quality treatment. The tunnel discharge volumes to the pond are documented in the February 21, 2007 memo.

E – e. How does the final outlet affect the current in the Minnesota River and will it be a hazard to tow boats and private water craft?

Answer: MnDOT is aware of the potential affects of stormwater outfalls on barge navigation. This was addressed in the February 21, 2007 memo in the answer to Question 9 (quoted below) and would be further addressed in final design.

Energy dissipation structures would be incorporated into the outlet from the tunnel to the West Pond water quality pond (both with and without rate control). The pond would be designed in a two-cell arrangement with the first smaller cell to allow further energy dissipation before flowing into the second cell. (The volume of the first cell would be considered ineffective in determining the required water quality storage volume.) This would improve the settling characteristics of the second cell.

The overflow from the pond to the river would likely be over a weir designed to cause low exit velocities and reduce the potential of a surface jet or current crossing the river and affecting barge traffic. Discharge volume and rate through the Almaz Pond outfall will decrease as a result of the project.

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April 5, 2007

Mr. Terry Schwalbe, Administrator
Board of Managers
Lower Minnesota River Watershed District
1600 Bavaria Road
Chaska, MN 55318

Re: I-494 Drainage Alternatives Analysis

Dear Mr. Schwalbe:
Dear Board of Managers

Working on behalf of MnDOT, Wenck is teamed Stanley Consultants, Inc. to study and compare drainage alternatives for the portion of I-494 from Penn Avenue to the Minnesota River crossing. Our study will compare five main alternatives to drain the corridor, with the future reconstruction of the roadway. (Note that the project currently is not in MnDOT's 20-year plan.) Each alternative will be designed to meet relevant rules in terms of water quality and discharge rate, including those of the Lower Minnesota River Watershed District.

This letter is to inform you of our hydrologic design activities related to the referenced study. Specifically, we plan to, on behalf of MnDOT, request a resolution of your Board agreeing in principal that detention storage would not be required to match the existing peak discharge rates at the project outfalls to the Minnesota River. The project would meet all other rules, including water quality.

Since the existing drainage system is under-capacity, surface flooding occurs for large storm events and limits the system discharge. Once flooding is eliminated in the future project, the peak discharge will increase. However, for both the with- and without-detention conditions, most of the water volume from the project drains to the river within approximately five hours. Given the size and timing of flooding on the Minnesota River, and the relatively small volume from I-494, detaining the water is likely to have no benefit in terms of peak flood stages. That is, in both cases, the peak on the River will occur much later than the discharge from the I-494 drainage system. A memo comparing the hydrographs is attached.

MnDOT, Wenck and Stanley staff have already met with Terry Schwalbe, and I have met with your Engineer Dan Edgerton to explain the project and discuss the kinds of additional supporting documentation which may be useful to the Managers in reaching their conclusions. We will provide you with that information and would like to request an opportunity to present it to the Board at its December 20, 2006 meeting. As we discussed with Terry, with your agreement, we would then work with him to draft resolution language, and attend your next meeting in January to answer any questions before you act on the resolution.

In addition to the attached hydrograph analysis, we plan to prepare and document for you the following in support of the resolution:

- Relevant data from previous studies.
- Discharge hydrograph analysis (XP-SWMM) of the I-494 corridor as documented previously.
- Analysis of project effects on Minnesota River hydrographs in terms of timing and rate for the October 4, 2005 storm.
- Analysis of potential stage effects of the project on stages on the Minnesota River.
- General description of the outfall structure to the Minnesota River and the types of measures that would be employed to control localized erosion at the site.
- Documentation of any hardship conditions (e.g., conveyance reduction due to the construction of a pond, difficulty in operation of an orifice on an underground tunnel/storage facility) that would result from rate control requirements.

MnDOT would most certainly appreciate any preliminary comments or concerns you may have with our approach or objectives. Please contact me with any of your concerns at 763 479 4234.

Sincerely,

WENCK ASSOCIATES, INC.

John R. Thene, P.E.
Principal Engineer

cc: Beth Neuendorf, P.E., Metro Area Water Resources Engineer, MnDOT
Alan J. Palmer, P.E., Principal Transportation Engineer, Stanley Consultants, Inc.

Lower Minnesota River Watershed District

Len Kremer, President
Hennepin County
Ron Kraemer, Vice President
Dakota County
Lawrence Samstad, Manager
Scott County

Kent Francis, Secretary
Carver County
Edward A. Schlampp, Treasurer
Hennepin County
Terry L. Schwalbe, Administrator
Cell (952) 221-1089

LOWER MINNESOTA RIVER WATERSHED DISTRICT

RESOLUTION NO. 2007-01

Interstate Highway 494 – Penn Avenue to Minnesota River

WHEREAS, the Minnesota Department of Transportation (MnDOT) is studying stormwater drainage alternatives for the portion I-494 from the Penn Avenue low point to the Minnesota River, and has provided information about the alternatives and their effect on the Minnesota River to the Board of Managers and has requested a determination that their Alternative 1C be determined to be eligible for exemption from the District's rate control requirement as documented in a technical memorandum *(Subject: MnDOT – I-494 Stormwater Alternatives Study (Penn Avenue to Minnesota River) Technical support for resolution by Lower Minnesota River Watershed District Board regarding rate control requirements)* dated February 2007 and presented to the Managers at their February 21, 2007 meeting; and

WHEREAS, the existing I-494 drainage system is undersized for present and future conditions; and

WHEREAS, the I-494 drainage investigation is being undertaken as part of long-term planning for a future roadway expansion project and MnDOT is not applying for a LMRWD permit at this time; and

WHEREAS, MnDOT has addressed questions raised by the LMRWD Board of Managers; and

WHEREAS, the information presented to the Board supports a finding that requiring rate control for Alternative 1C would not have a beneficial effect on Minnesota River flood stages, and a rate control pond would displace existing floodplain storage volume and reduce river conveyance; and

WHEREAS, the soils at the West Pond site are poor and incapable of supporting the dike structures necessary to construct a rate control pond; and

1600 Bavaria Road, Chaska, MN 55318
Terry Schwalbe: 952-227-1037; Joan Ellis: 952-227-1038; Fax: 952-227-1039
E-mail terrys@lowermn.com; joane@lowermn.com

Lower Minnesota River Watershed District

WHEREAS, the request by MnDOT is limited to this I-494 drainage project, and MnDOT will meet other LMRWD Design Considerations including water quality.

NOW THEREFORE BE IT RESOLVED, the LMRWD Board of Managers conceptually agree at this point in time with the Minnesota Department of Transportation that the Alternative 1C, as will be further developed in the study, could be permitted in the future without meeting rate control requirements of the LMRWD Design Considerations; and

BE IT FURTHER RESOLVED, the above determination that the Alternative 1C could be permitted without meeting rate control requirements of the LMRWD Design Considerations is made under the current regulatory conditions affecting the LMRWD and MnDOT, a future Board may decide not to so permit Alternative 1C under these conditions, and this resolution would not be binding on a future Board during the future permitting of the project, nor would it exempt MnDOT from the requirements of any future regulations or future LMRWD Rules; and

BE IT FURTHER RESOLVED, the I-494 drainage system from Penn Avenue to the Minnesota should be designed to meet all other LMRWD Design Considerations.

Adopted: 05/16/2007

LOWER MINNESOTA RIVER WATERSHED DISTRICT

By: _____
Len Kremer, President

103850 doc

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March 21, 2007

MEMO

To: LMRWD Board of Managers, Staff

From: Lawrence Samstad, P.E., Scott County Manager

Re: MnDOT – I-494 Stormwater Alternatives Study

In reviewing Mr. John Thene's PE replies to my questions forwarded to him by Terry Schwalbe, I find that the answers are not as clear and definitive as they should be considering that MnDOT wants the Managers to sign an agreement for only a portion of the above study. The proposed agreement amounts to a 'carte blanche' where the final results of the study may not be in the best interests of the Lower Minnesota River Watershed District. May I take the opportunity to review the responses by lettered questions and the responses from Mr. Thene.

A. Technical Paper 40 was derived of sparse information acquired by the U.S. Weather Bureau in the 30's, 40's and 50's. Since then, more detailed information has been acquired by the U.S. Weather Bureau in conjunction with local information from reliable sources. A portion of that information was released in a report "Sixteen Year Study of Minnesotta Flash Floods – January 1988". Since 1988 (almost 20 years later) no revision has been made to the MnDOT chart of flooding frequencies. Even though T.P. 40 clearly states the for any given frequency, one must have two and one half times that frequency in record to support the results of that frequency result (rainfall amount and rainfall intensity maximas.) In the 18 years of the study 59 storms have equaled or exceeded the 100 year event in the State of Minnesota. A good reason for revising MnDOT's graph on frequency. A graph which has been used for the last 40 to 50 years by Engineers and Weathermen alike. The point is – isn't it about time to come out of the "Dark Ages" of improper frequency relationships? Why do we need to wait for the I-494 study to complicate this "fiction" further?

B. The question was not whether the Smith or Wright Ponds were changed, but rather were the watersheds of these ponds (in whole or in part) made a part of the I-494 study? If so, how much? The answer is unclear and seems to be hedging as to whether those former watersheds will be a part of the I-494 study.

C. Again, to use the 100 year frequency peak discharge is to use a discharge that is not supported by 250 years of frequency record. What fictitious figure will be used for this calculation?

D. The answer does not describe the size, location or outlet of any proposed pond. Considering the limited space in this area according to recent negotiations with MnDOT on dredge material sites, isn't this a pertinent question at this point?.

E. Areas will be required to accommodate an energy dissipator as well as a pond. Where does this space exist?

Based on the equivocation in the answers of Mr. Thene, and based on my knowledge of the District's desires I respectfully request the Board of Managers withhold their signatures on the proposed contract with MnDOT until significant answers are forthcoming without evasion and/or hedging.

Approved minutes of March 21, 2007

8. PRESENTATIONS FOR BOARD ACTION

a. Int. 494 to Penn Avenue report and resolution, John Thene, Wenck Associates, Inc.
The resolution is acceptable to staff members Mr. Malkerson and Mr. Schwalbe. Mr. Samstad submitted a memorandum dated March 21, 2007 attached hereto and made a permanent part of the public record responding to Chris Meehan and John Thene's response memorandum dates February 21, 2007 to the board.

President Kremer confirmed that this concept plan is not in MNDot's 20 year plan and said when the project goes to preliminary design, then should look at Mr. Samstad's concerns.

It was moved and seconded to approve the Resolution 2007-01 Interstate 494 to Penn Avenue attached and is hereby made a permanent part of the public record and when the MN/Dot project, now presented in concept, goes to preliminary design that Mr. Samstad's concerns addressed in his memorandum dated March 21, 2007 be attached to the Resolution as an appendix to the Resolution and to be considered by a future board. VOTE: Ayes 3; Nays 1. Motion passed.

Mn/DOT POLICY
POSITION STATEMENT

Date: June 16, 1989

Reference: Multimodal No. 89-1
Emergency Operations;
Hazardous Materials
Spills, Abandonment

Position Statement:

This policy sets forth procedures to follow should an emergency situation occur resulting from the release or abandonment of hazardous material on trunk highway right-of-way. In the normal course of day to day business, Department of Transportation personnel involved in maintenance of our highways may encounter or be requested to respond to incidents that involve hazardous materials. Mn/DOT employees are frequently notified about hazardous material spills or abandoned hazardous cargoes on our highways, and asked to contain the spilled material or pick up the abandoned cargo. Generally the hazardous material does not pose an immediate health hazard. A hazardous material may be released however, that does pose an imminent and substantial danger to the public health, welfare or the environment as well as to Mn/DOT personnel. Proper emergency response and coordination procedures are therefore required.

Background:

Mn/DOT is required, pursuant to applicable Minnesota law and Executive Orders, to prepare plans and instructions for the protection of the public and personnel along with procedures for participation in emergency operations. Furthermore, coordination with several state agencies is required during the response to an emergency situation. The appendices attached explain the responsibilities of the several agencies in administering the state's response to hazardous waste emergencies.

LEONARD W. LEVINE, Commissioner

Any questions regarding this position statement should be directed to:
Leo J. Holm, Geotechnical Engineering Section, Room 132 Transportation Building,
Telephone (612) 296-3766.

Background Information Pertaining
To State Agency Responsibilities In
Administering Hazardous Waste Emergencies

Date: June 16, 1989
Reference: Multimodal 89-1

APPENDIX A
DEFINITIONS

Hazardous Materials are substances which present health or environmental hazards. These substances are dangerous because of their toxicity, ignitability, reactivity, or corrosivity. They include, but are not limited to explosives, flammables, corrosives, poisons, solvents, and radioactive materials.

The HAZMAT (Hazardous Materials) Team is a group of hazardous materials response technicians, trained and certified by the Department of Public Safety, Division of Emergency Services. These technicians respond, when dispatched by the Division of Emergency Services, to any hazardous materials incident in the State, 24 hours per day, seven days per week, in accordance with Standard Operating Procedures. The HAZMAT Team has specially designed equipment and transportation units. State agencies providing personnel to the HAZMAT Team are: the Pollution Control Agency, the Department of Public Safety, the Department of Agriculture, and the Department of Transportation.

APPENDIX B
STATE AGENCY RESPONSIBILITIES

COORDINATION OF STATE RESPONSE ACTIVITIES

Coordination of Statewide emergency response activities is vested in the Department of Public Safety, Division of Emergency Services. The Director of the Division of Emergency Services serves as the State hazard mitigation coordinator, coordinating all hazard mitigation action requirements through responsible State agencies and with local units of government. The Division of Emergency Services also coordinates the HAZMAT Team.

STATE AGENCY RESPONSIBILITIES

Although several State agencies are identified in the current Executive Order (No. 85-9), the following are more directly involved during an emergency situation resulting from the release of a hazardous material on Mn/DOT right-of-way.

1. The Department of Public Safety, Division of Emergency Services is responsible for receiving notification of any emergency associated with hazardous materials and then alerting State agencies and coordinating the response. Telephone numbers have been established for this purpose. In the Minneapolis/St. Paul Metropolitan area please call (612) 649-5451. If calling from any Out-State location call, toll-free, 1-800-422-0798.

2. The Department of Public Safety State Patrol Division is responsible for law enforcement and traffic control on all interstate and State highways during an emergency and will assist in hazard mitigation efforts in the State as requested by the Division of Emergency Services.

3. The Pollution Control Agency (PCA) is responsible for development and enforcement of containment, clean-up, and disposal procedures for hazardous materials, and for coordinating the containment and clean-up of polluting substances.

4. The Department of Agriculture will support response activities during emergencies resulting from release of pesticides and fertilizers.

5. The Department of Health will support response efforts to hazardous materials incidents and will determine mitigation efforts to reduce or eliminate potential health hazards.

6. Local Emergency and Law Enforcement Agencies assist in the response effort. Local Fire Departments will be responsible for controlling flammable materials. They will generally coordinate and assist in response activities with the Department of Public Safety and the HAZMAT Team.

MN/DOT RESPONSIBLILITIES

Mn/DOT emergency responsibilities relating to hazardous materials incidents on highway rights-of-way as specified in the Executive Order (No. 85-9) are as follows:

1. Mn/DOT will prepare emergency highway traffic regulation plans and procedures for regulating highway travel.

   (Mn/DOT has prepared this information and it has been issued under Mn/DOT Policy Position Statement; Highways No. 83-2.)

2. The Maintenance/Construction Communications System will be made available to supplement or replace the State Patrol radio network should it fail.

3. Mn/DOT is responsible for debris and wreckage removal from all interstate and state trunk highways and for other assistance to political subdivisions on other roadways as may be required.

4. Mn/DOT will assist in hazard mitigation efforts to reduce or eliminate potential hazards that endanger motorists or the citizens of the State.

5. The Program Management Division will disseminate information to appropriate agencies concerning the shipment of chemicals, radiological substances and other materials that are potentially hazardous.

In addition to the above responsibilities, Mn/DOT is responsible for providing trained personnel to the HAZMAT Team.

EMERGENCY RESPONSE PROCEDURES
WHEN
HAZARDOUS MATERIALS ARE RELEASED OR ABANDONED
ON TRUNK HIGHWAY RIGHT OF WAY

Date: June 16,1989
Reference: Multimodal No. 89-1-P-1

Issued Under: Mn/DOT Policy Position Statement
Multimodal No. 89-1

Mn/DOT Policy Guideline
Multimodal No. 89-1-G-1

A. Emergency Response

Response to any emergency involving hazardous materials must be done in such a manner that Mn/DOT employees and the general public remain safe. Mn/DOT employees are to assist in an emergency response, if it can be done safely, under the direction of the Division of Emergency Services. Mn/DOT involvement should be limited to furnishing and transporting containment materials such as sand, helping reroute traffic, providing communication and assisting with removal of debris.

1. In a situation where Mn/DOT is the first agency notified that an accident or spill resulting in a potentially hazardous situation has occurred, or where Mn/DOT discovers such an occurrence or the presence of abandoned hazardous cargo, the following procedures should be followed. The Area Maintenance Engineer or his designee is responsible for insuring that employees who respond to an accident are instructed in these procedures and have received training to enable them to respond to an emergency situation in a safe and expedient manner. (A training program is beyond the scope of this policy. Training will be developed following policy implementation.)

   a. Immediately contact the Department of Public Safety, Division of Emergency Services Duty Officer at (612) 649-5451 or 1-800-422-0798 utilizing available phones or Mn/DOT radio dispatch if in the field.

      Relay as much information as possible about the spill including: the exact location of the accident, identity of the spilled material if known, and type of immediate or potential danger (i.e., fire, explosive, poison, restricted visibility, contamination of air or water).

   b. Reroute, if possible, or stop traffic until the State Patrol or other law enforcement can assume control.

   c. Avoid exposure to the hazardous material Take emergency action only as necessary to protect human life.

   Upon arrival of emergency or law enforcement personnel, make sure they are fully informed about the hazardous situation.

2. In situations where Mn/DOT is requested by the Division of Emergency Services, the Highway Patrol, or local emergency agencies to respond to a hazardous materials incident, the Area Maintenance Engineer or his designee is responsible for implementing the following procedures:

   a. Before dispatching Mn/DOT employees to the scene of a spill or abandoned cargo, the Area Maintenance Engineer or his representative should obtain information including: the name of the material, if known, and whether the material is hazardous; what hazards are associated with the

material; location of the spill or abandoned cargo; the type of assistance needed and whether the assistance includes containment procedures or removal of debris.

b. The person receiving notification should inquire whether the Division of Emergency Services has been contacted. If not, relay all known information to the Duty Officer at the Division of Emergency Services by immediately calling (612) 649-5451 or 1-800-422-0798.

c. Only after the hazardous material has been identified and Emergency Services has determined that Mn/DOT personnel can interact with the material or cargo without threat to their health or safety, maintenance crews and equipment can be deployed to assist with the response effort. Records shall be kept on the material involved, the date of the incident, what safety precautions were taken, how long employees were exposed to the material, where the material was taken and the name of any person or agency contacted.

B. Cleanup

If there is a release of a hazardous material on the roadway and/or right-of-way which either poses or may pose an Imminent and substantial danger to public or Mn/DOT employee health or the welfare of the environment, Mn/DOT employees may not be engaged in cleanup activities. In these situations, a contractor experienced in Cleanup of hazardous materials should be utilized if normal operating procedures cannot be followed. Mn/DOT Personnel involvement will be limited to assisting with traffic routing during cleanup activity.

If the material released on the roadway and/or the right-of-way is not classified as being hazardous, cleanup can be Undertaken by Mn/DOT maintenance forces. Cleanup must be performed in a manner which safeguards the environment and in accordance with Pollution Control Agency regulations. In all cases the Pollution Control Agency must be contacted and must approve the cleanup and disposal methods prior to commencing the cleanup action.

Mn/ DOT, in accordance with the Executive Order, will remove all non-hazardous debris as necessary to return the roadway to a safe operating condition.

C. Carrier Responsibility

After the emergency has ended and there is no longer imminent danger, information should be obtained about the carrier(s) and their shipment for billing purposes.

The carrier is responsible for any spilled hazardous material, any abandoned hazardous cargo, and all materials that become contaminated during cleanup. The carrier is also responsible for returning all contaminated right-of-way to a suitable condition.

The carrier or the carrier's insurance company must be notified in writing by the Area Maintenance engineer that they are responsible for the ultimate removal and disposal of all material within 30 days. A copy of the letter must also be sent to the PCA. If no action is taken by the carrier or the carrier's insurance company within the 30 day period, the PCA Hotline or the Attorney General's Criminal Division should be contacted to initiate criminal prosecution.

D. Abandoned Barrels Program

The Pollution Control Agency has instituted a program to identify and handle abandoned barrels in response to citizen complaints or upon notification by State agencies. The program is directed towards barrels left abandoned on roadsides or in citizens' yards and in situations where the responsible party cannot be identified. The program does not apply to situations where property was purchased with barrels left or stored upon it.

If barrels are found abandoned on Mn/DOT right-of-way, the Department of Public Safety, Division of Emergency Services Duty Officer at (612) 649-5451 or 1-800-422-0798 should be contacted.

1. The on-call response person will contact the District Safety Office who will be requested to make an on-site inspection and note labeled contents if discernible and determine responsible party, if possible.

2. The on-call team member will then contact the Pollution Control Agency to initiate the abandoned barrels program if appropriate.

3. If an emergency situation exists the on-call team member will direct an appropriate response.

B. Cost Recovery

Costs incurred by Mn/DOT for materials, equipment, and personnel involved in containment of hazardous material from known persons will be charged to the carrier or their insurance company. The PCA must be contacted regarding disposal of hazardous materials from unknown sources or carriers. It is the responsibility of the Maintenance Engineer to ensure that the costs are adequately recorded and of the Office Managers to ensure proper billing.

Minnesota Department of Transportation
Maintenance Bulletin Number 97-1
January 31, 1997

TO: Operations Management Group
Maintenance Superintendents
Maintenance Supervisors
Safety Professionals
State Highway Patrol

FROM: Rodney A. Pletan
State Maintenance Engineer

SUBJECT: Roadway Accident Scene Vehicle Fluid Spill Response Procedure

INTRODUCTION

On many occasions Mn/DOT personnel are the first at a highway motor vehicle accident scene. Vehicle fluids such as gasoline and/or diesel fuel are found draining down the curb or shoulder contaminating the environment. Clean up cost of those spills can be immense. Worse yet, the public may be trapped in their vehicle with fuel spreading under them. Ignition could prevent rescue and cause severe burns or fatalities. This procedure provides a means of reducing these potentially high risk situations. It applies to containment and not clean-up of motor vehicle fluids, and it is to be used, in supplement, to Mn/DOT Policy Guideline, Multimodal No. 89-1-G-1.

SPILL RESPONSE COVERAGE

These guidelines cover those Mn/DOT employees arriving at a motor vehicle accident scene where the motor vehicle's own liquids such as gasoline, diesel fuel, hydraulic fluid, transmission fluid, engine oils and radiator fluids have spilled. This procedure <u>does not</u> cover spillage from cargo loads.

GUIDELINES FOR MOTOR VEHICLE FLUID SPILLS

A) When arriving at a motor vehicle accident scene, evaluate the situation and notify your dispatcher. Request the dispatcher to:

1) Summon the State Patrol or the local Police and other emergency services personnel.

2) If needed, request an ambulance.

3) If needed, request additional traffic control.

4) If a spill of a hazardous substance is found, have the dispatcher call the State Duty Officer at 649-5451 or 1-800-422-0798. This must be done to ensure that the call is properly logged.

   (a) If possible, provide information on the motor vehicles involved in the incident and the phone numbers of the owners.

   (b) Provide other details such as product, amount, etc.

B) After completing Section "A" of these guidelines, the following can be addressed:

IF...
it can be done safely.
the appropriate sorbent or containment materials are available.
spillage does not include cargo load.

1) Assess the spill to determine the identity of motor vehicle fluid and determine safety precautions needed as instructed at annual "Right -To-Know" training.

2) Determine if the motor vehicle fluid spill can be contained safely and effectively:

   (a) Determine a safe distance in relation to motor vehicle fluid type and quantity of spill.

   (b) If sorbent and containment products are available and can be applied safely, they may be used to absorb or contain spilled hydrocarbons.

   (c) To stop down grade drainage the sorbent/containment product should be used to dike the drainage until haz-mat teams arrive to take control. If you have enough sorbent/containment product, adsorb the puddle to prevent overflow or flooding from the diked area of containment.

C) Mn/DOT's costs for containment of motor vehicle fluid spills are to be compiled by the maintenance area involved and billed to the vehicle's owner or the owners insurance carrier.

SPECIAL NOTE ON CLEANUP:

Mn/DOT employees are allowed to help contain and clean up motor vehicle's own liquids in order to open roadways more quickly for public use. Sorbent products, and as a last option sand, may be used to contain liquids such as radiator, transmission and hydraulic fluids as well as engine oil, gasoline and diesel fuels at the scene. After containment, the spilled product may be removed from the roadway and protected from the elements by Mn/DOT employees. The contained fluids are to be placed off the traveled roadway, nearby, for pickup. Mn/DOT employees involved in such activities must have annual "Right-To-Know" training dealing with these liquids. Hazardous material contractors called to the site assume complete control and cleanup responsibilities from Mn/DOT upon arrival. Mn/DOT personnel are then relieved of all work involving cleanup of the spilled materials. Contact the Office of Environmental Services for technical information on available sorbent products (612-779-5100).

Memorandum

1800 Pioneer Creek Center, Maple Plain, MN 55359
Phone: 763-479-4200 Fax: 763-479-4242

Wenck

To: Files

From: John R. Thene, P.E.

Date: April 5, 2007

Subject: I-494 Stormwater Alternatives Study
Water Quality Pond and Sediment Evaluation

Introduction

This memorandum is prepared to document the evaluation of pond performance of Alternatives 1, 2, 4 and 5.

The dead volume of water quality ponds is generally determined as equal to the runoff from a 2.5-inch storm (MPCA, 1989). The runoff volumes for these calculations were determined by SCS Curve Number method. In each case, ponds are intended to remove 50 percent of influent phosphorus based on the runoff from a 2.0-inch storm. The additional volume is to allow for sedimentation in the time between maintenance excavation. For this reason, the ponds are sized to provide 50 percent removal when 20 percent of their volumes were consumed by sedimentation.

Alternative 1C:

In Alternative 1C, the 52 acre-feet of runoff from the 2.5-inch rainfall event would be split between the West Pond (approximately 38 acre-feet) and Almaz Pond (about 14 acre-feet). The Almaz Pond volume 19 acre-feet is somewhat oversized and exceeds water quality requirements with 54 percent phosphorus removal. By sizing the West Pond water quality (dead) volume at 34 acre-feet, its removal rate is 49 percent and the combined removal is 50 percent. Attachment 1 is a PondNet spreadsheet model to evaluate the combined performance of each of the ponds. The West Pond volume was increased to the point where total removal was equal to 50 percent as summarized below:

		Almaz Pond	West Pond
Runoff from 2.5-inch storm	[ac-ft]	14	38
Dead Volume	[ac-ft]	19	34
Effective Volume (after sedimentation)	[ac-ft]	15.2	27.0
Estimated residence time	[d]	22	15 d
Removal rate (Attachment 1)	[--]	53.9 %	48.6 %
Total Removal Rate: 50 % = (14*53.9% + 38*48.6%)/(14+38)			

Alternative 2C:
The Alternative 2C water quality ponding system includes ponds in series and in parallel: Discharge from Penn pond flows through the Wentworth pond, and discharge from the Wentworth, Portland, and TH 77 ponds, plus untreated flows, flow through Almaz Pond. The analysis of phosphorus removal was completed using the PondNet spreadsheet model. The ponds were sized according to the runoff volume from the 2.5-inch rainfall event. The PondNet analysis was used to show 50 percent phosphorus removal when the pond volumes are reduced by 20 percent to account for sediment accumulation in the ponds. Analysis of the complete system showed an overall removal rate of 54 percent. Total pond dead storage volume is 56 acre-feet.

		Penn	Wentworth	Portland	TH77	Almaz	System
Runoff from 2.5-inch storm	[ac-ft]	2.8	16.2	6.1	8.9	52.0	52
Dead volume	[ac-ft]	3.2	19.1	6.1	8.9	19.0	56
Effective Volume (after sedimentation)	[ac-ft]	2.6	15.3	4.9	7.1	15.2	45
Estimated residence time	[d]	18.7	19.1	6.1	8.9	19.0	56
Removal rate (Attachment 1)	[--]	50%	49%	50%	50%	30%	54%

Alternative 2C; Variant with No Penn Avenue Dead Volume:
A variant to Alternative 2C Variant removes the dead volume at Penn Avenue, creating a dry pond. The Wentworth Avenue pond was increased in volume according to the Alternative 2C Penn Avenue pond volume. The system, with 53 acre-feet of dead storage volume, showed an overall phosphorus removal rate of 53 percent:

		Wentworth	Portland	TH77	Almaz	System
Runoff from 2.5-inch storm	[ac-ft]	19.1	6.1	8.9	18.0	52
Dead volume	[ac-ft]	19.1	6.1	8.9	19.0	53
Effective Volume (after sedimentation)	[ac-ft]	15.3	4.9	7.1	15.2	45
Estimated residence time	[d]	19.1	6.1	8.9	19.0	56
Removal rate (Attachment 1)	[--]	50%	50%	50%	30%	53%

Alternative 2D:
In Alternative 2D, the 52 acre-feet of runoff from the 2.5-inch rainfall event would be split between the West Pond (30 acre-feet) and the existing Almaz Pond (22 acre-feet). Therefore, the Almaz Pond volume (19 acre-feet) is undersized and the West Pond water quality (dead) volume must be raised to 34 acre-feet in order to achieve a system phosphorus removal of 50 percent; with depth of six feet and a 10-ft safety bench, the area of the pond at normal water level would be 6.3 acres.

		Almaz Pond	West Pond
Runoff from 2.5-inch storm	[ac-ft]	22	30
Dead Volume	[ac-ft]	19	34

Effective Volume (after sedimentation)	[ac-ft]	15.2	27.2
Estimated residence time	[d]	14.2	18.6
Removal rate (Attachment 1)	[--]	48.7 %	51.4 %
Total Removal Rate: 50 % = (22*48.7% + 30*51.4%)/(22+30)			

Alternative 2F:

In Alternative 2F, the 52 acre-feet of runoff from the 2.5-inch rainfall event would be split between the West Pond (29 acre-feet) and the existing Almaz Pond (23 acre-feet). Therefore, the Almaz Pond volume (19 acre-feet) is undersized and the West Pond water quality (dead) volume must be raised to 34 acre-feet in order to achieve a system phosphorus removal of 50 percent; with depth of six feet and a 10-ft safety bench, the area of the pond at normal water level would be 6.3 acres.

		Almaz Pond	West Pond
Runoff from 2.5-inch storm	[ac-ft]	23	29
Dead Volume	[ac-ft]	19	34
Effective Volume (after sedimentation)	[ac-ft]	15.2	27.2
Estimated residence time	[d]	13.5	19.2
Removal rate (Attachment 1)	[--]	48.6 %	51.8 %
Total Removal Rate: 50 % = (23*48.6% + 29*51.8%)/(23+29)			

Alternative 4A:

In Alternative 4A, the 52 acre-feet of runoff from the 2.5-inch rainfall event would be split between the proposed I-35W outfall pond (38 acre-feet) and the existing Almaz Pond (14 acre-feet). The Almaz Pond volume (19 acre-feet) is adequate to meet water quality requirements for its discharge. Therefore, the I-35W Pond water quality (dead) volume is 38 acre-feet; with depth of six feet and a 10-ft safety bench, the area of the pond at normal water level would be 7.0 acres.

		Almaz Pond	I-35W Pond
Runoff from 2.5-inch storm	[ac-ft]	14	38
Dead Volume	[ac-ft]	19	38
Effective Volume (after sedimentation)	[ac-ft]	15.2	30.2
Estimated residence time	[d]	22.3	16.3
Removal rate (Attachment 1)	[--]	54 %	50 %
Total Removal Rate: 51 % = (14*54% + 38*50%)/(14+38)			

(On the basis of the PondNet water quality model, the Alternative 4A I-35W Pond volume could be reduced to 34 ac-ft and still meet the overall phosphorus reduction of 50 percent, since Almaz is oversized. The area of the reduced pond would be 6.3 acres.)

Alternative 5:

The Alternative 5 conveyance system overloads the water quality volume provided by Almaz Pond. Almaz Pond cannot be expanded due to site constraints. Therefore the West Pond water quality volume must be oversized to compensate for the reduced residence time, and hence phosphorus removal, in Almaz. Attachment 1 is a PondNet spreadsheet model to evaluate the performance of each of the ponds. The West Pond volume was increased to 33 ac-ft so that the total volume is equivalent the 52 ac-ft required in the LMRWD rules. The total removal estimated this way with the PondNet model was equal to 47 percent as summarized below:

		Almaz Pond	West Pond
Runoff from 2.5-inch storm	[ac-ft]	36	16
Dead Volume	[ac-ft]	19	33
Effective Volume (after sedimentation)	[ac-ft]	15.2	26.5
Estimated residence time	[d]	9	34
Removal rate (Attachment 1)	[--]	42 %	57 %
Total Removal Rate: (36*42% + 16*57%)/(52) = 47 %			

With the oversizing at West Pond, further increases in size will not provide a net 50 percent removal with reasonably sized ponds. (Doubling the size of West Pond would only reach 48 percent removal.) If Almaz Pond is kept free of sediment accumulation, the modeled system performance would meet the 50 percent threshold.

References:

Minnesota Pollution Control Agency, 1989. Protecting Water Quality in Urban Areas, Best Management Practices for Minnesota, St. Paul, Minnesota.

Walker, William W. Jr., 1987. "Phosphorus Removal by Urban Runoff Detention Basins", *Lake and Reservoir Management, Volume III*, North American Lake Management Society, pp 314-326.

Attachments

1. PondNet analysis of Alternatives 1C, 2C, 2D, 2F, 4A and 5A.

Key Pond Modeling Variables and Equations from PondNet

Sources 1. PondNet spreadsheet by W. Walker, 1989. Adapted by Wenck Associates, Inc.

2. W. Walker, 1987, Phosphorus removal by urban runoff detention basins, Lake and Reservoir Management, Vol. III, pp. 314.

Variable	Units	Description	Equation
R_p	[--]	Fraction of inflow P retained	1-((1+4*Nr)^0.5-1)/(2*Nr)
N_r	[--]	dimensionless reaction rate	K2*Pi*Tr
K_2	[m^3/mg/yr]	Second order decay rate coefficient	0.056*Qs/Fo/(Qs+13.3*3.28)
Q_s	[ft/yr]	Mean surface overflow rate	D/Tr or Inflow Volume divided by Area
F_o	[--]	Inflow Ortho P : Total P ratio	Input
P_i	[mg/m^3 or ug/L]	Flow-weighted average inflow TP	Input
T_r	[yr]	Hydraulic residence time in years	Input

Model Case	Panzer Pond			==> Evaluation Period	240 [d]	[d]	Whole
				Evaluation Period	0.66 [yr]	[yr]	System
				Volume Reduction due to Sedimentation:	20%		
				Remaining Volume	80%		
	Modeled Total Phosphorus Removal for Total Pond System:				**50.0% [--]**	[--]	
Pond Size	Cell No.			**Cell 1**		**Cell 5**	
	==> Name or Description		[--]	West Pond		Almaz	
	Potential Area	Ap	[ac]				
	==> Pond Surface Area	Ap	[ac]	6.20		3.17	
	Pond Avg Depth before Sedimentation	D	[ft]	5.43		6.00	
	==> Pond Avg Depth (After Sedimentation)	D	[ft]	4.34		4.80	
	Pond Volume (Before Sedimentation)	V	[ac-ft]	33.7		19.0	53
	Pond Volume (After Sedimentation)	V	[ac-ft]	26.93		15.22	42
Inflows	==> Runoff from 2.5 inch event	Aws	[ac]	38.0		14.0	52
	==> Runoff Coefficient (V/P)	C	[ac-ft/in]	15.2		5.6	
	==> Evaluation period precipitation	Pe	[in]	29.3		29.3	
	Pond inflow from runoff	Qr	[ac-ft]	445.4		164.1	
	Pond inflow from upstream pond	Qus	[ac-ft]	-		-	
	==> Pond inflow from point sources	Qp	[ac-ft]	-		-	
	Total pond inflow	Qi	[ac-ft]	445.4		164.1	
Concentrations	==> Inflow concentration of runoff	Pr	[ug/L]	300		300	
	Inflow concentration from upstream pond	Pus	[ug/L]	-		-	
	==> Inflow concentration from point sources	Pp	[ug/L]	-		-	
Inflow Loads	Pond load from runoff	Lr	[lb]	362.6		133.6	496
	Pond load from upstream pond	Lus	[lb]	-		-	
	Pond load from point sources	Lp	[lb]	-		-	
	Total load to pond	Li	[lb]	362.6		133.6	
Model Input	Average pond inflow concentration	Pi	[ug/L]	300		300	
	==> Inflow Ortho P : Total P ratio	Fo	[--]	0.26		0.26	
	Hydraulic residence time	Tr	[yr]	0.040		0.061	
		Tr	[d]	14.5		22.3	
	Mean surface overflow rate	Qs	[ft/yr]	109.2		78.7	
	==> Relative decay rate	[--]	[--]	1		1	
Model Calculations	Second order decay rate coefficient	K2	[m^3/mg/yr]	0.154		0.139	
	Dimensionless reaction rate	Nr	[--]	1.84		2.54	
	Fraction of inflow P removed	Rp	[--]	49%		54%	
	Outflow load as percent of inflow load	1 - Rp	[--]	51%		46%	
Pond Performance	Phosphorus load removal		[lb]	176.1		72.0	248
	Phosphorus load removal		[--]	48.6%		53.9%	50%
	Outflow phosphorus load		[lb]	186.5		61.6	248
	Outflow phosphorus load		[--]	51.4%		46.1%	50.0%
	Outflow phosphorus concentration		[ug/L]	154		138	

Model Case	Panzer Pond		==>	Evaluation Period		240	[d]	[d]	Whole
				Evaluation Period		0.66	[yr]	[yr]	System
	Volume Reduction due to Sedimentation:					20%			
	Remaining Volume					80%			
	Modeled Total Phosphorus Removal for Total Pond System:					**53.6%**	**[--]**	[--]	
Pond Size	Cell No.			**Cell 1**	**Cell 2**	**Cell 3**	**Cell 4**	**Cell 5**	
	==> Name or Description		[--]	Penn	Wentworth	Portland	TH77	Almez	
	==> Potential Area (Live Storage Base Area)	Ap	[ac]	0.80	3.30	4.80	1.70		
	==> Pond Surface Area	Ap	[ac]	0.80	3.30	1.22	1.70	3.17	
	==> Pond Avg Depth (Before Sedimentation)	D	[ft]	4.00	5.80	5.00	5.25	6.00	
	Pond Avg Depth (After Sedimentation)	D	[ft]	3.20	4.64	4.00	4.20	4.80	
	Pond Volume (Before Sedimentation)	V	[ac-ft]	3.2	19.1	6.1	8.9	19.0	56.4
	Pond Volume (After Sedimentation)	V	[ac-ft]	2.56	15.31	4.88	7.14	15.22	
	Modeled Runoff From 2.5-inch Event		[ac-ft]	2.6	16.2	6.1	8.9	18	52.0
Inflows	==> Watershed Area	Aws	[ac]	14.5	101.6	44.5	93.8	183.2	437.6
	==> Runoff Coefficient	C	[--]	0.927	0.765	0.658	0.455	0.472	
	==> Evaluation period precipitation	Pe	[in]	29.3	29.3	29.3	29.3	29.3	
	Pond inflow from runoff	Qr	[ac-ft]	32.8	189.9	71.5	104.3	211.0	
	Pond inflow from upstream pond	Qus	[ac-ft]	-	32.8	-	-	398.5	
	==> Pond inflow from point sources	Qp	[ac-ft]	-	-	-	-	-	
	Total pond inflow	Qi	[ac-ft]	32.8	222.7	71.5	104.3	609.4	
Concentrations	==> Inflow concentration of runoff	Pr	[ug/L]	300	300	300	300	300	
	Inflow concentration from upstream pond	Pus	[ug/L]	-	151	-	-	150	
	==> Inflow concentration from point sources	Pp	[ug/L]	-	-	-	-	-	
Inflow Loads	Pond load from runoff	Lr	[lb]	26.7	154.6	58.2	84.9	171.7	496
	Pond load from upstream pond	Lus	[lb]	-	13.5	-	-	157.4	
	Pond load from point sources	Lp	[lb]	-	-	-	-	-	
	Total load to pond	Li	[lb]	26.7	168.0	58.2	84.9	329.1	
Model Input	Average pond inflow concentration	Pi	[ug/L]	300	278	300	300	199	
	==> Inflow Ortho P : Total P ratio	Fo	[--]	0.26	0.26	0.26	0.26	0.26	
	Hydraulic residence time	Tr	[yr]	0.051	0.045	0.045	0.045	0.016	
		Tr	[d]	18.7	16.5	16.4	16.4	6.0	
	Mean surface overflow rate	Qs	[ft/yr]	62.4	102.6	89.1	93.3	292.4	
	==> Relative decay rate	[--]	[--]	1	1	1	1	1	
Model Calculations	Second order decay rate coefficient	K2	[m^3/mg/yr]	0.127	0.151	0.145	0.147	0.187	
	Dimensionless reaction rate	Nr	[--]	1.95	1.90	1.95	1.98	0.61	
	Fraction of inflow P removed	Rp	[--]	50%	49%	50%	50%	30%	
	Outflow load as percent of inflow load	1 - Rp	[--]	50%	51%	50%	50%	70%	
Pond Performance	Phosphorus load removal		[lb]	13.2	82.6	28.8	42.3	98.8	266
	Phosphorus load removal		[--]	50%	49%	50%	50%	30%	54%
	Outflow phosphorus load		[lb]	13.5	85.5	29.4	42.6	230.4	230
	Outflow phosphorus load		[--]	50%	51%	50%	50%	70%	46%
	Outflow phosphorus concentration		[ug/L]	151	141	151	150	139	

Model Case	Panzer Pond			==>	Evaluation Period	240	[d]	[d]	Whole
					Evaluation Period	0.66	[yr]	[yr]	System
	Input				Volume Reduction due to Sedimentation:	20%			
					Remaining Volume	80%			
					Modeled Total Phosphorus Removal for Total Pond System:	**53.1%**	[--]	[--]	
Pond Size	Cell No.				Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	
	==> Name or Description			[--]	Penn	Wentworth	Portland	TH77	Almaz	
	==> Potential Area (Live Storage Base Area)	Ap		[ac]		3.30	4.80	1.70		
	==> Pond Surface Area	Ap		[ac]		3.30	1.22	1.70	3.17	
	==> Pond Avg Depth (Before Sedimentation)	D		[ft]		5.80	5.00	5.25	6.00	
	Pond Avg Depth (After Sedimentation)	D		[ft]		4.64	4.00	4.20	4.80	
	Pond Vplume (Before Sedimentation)	V		[ac-ft]		19.1	6.1	8.9	19.0	53.2
	Pond Volume (After Sedimentation)	V		[ac-ft]		15.31	4.88	7.14	15.22	
	Modeled Runoff From 2.5-Inch Event			[ac-ft]		19	6.1	8.9	18	52.0
Inflows	==> Watershed Area	Aws		[ac]		116.2	44.5	93.8	183.2	437.7
	==> Runoff Coefficient	C		[--]		0.785	0.658	0.455	0.472	
	==> Evaluation period precipitation	Pe		[in]		29.3	29.3	29.3	29.3	
	Pond inflow from runoff	Qr		[ac-ft]		222.7	71.5	104.3	211.0	
	Pond inflow from upstream pond	Qus		[ac-ft]		-	-	-	398.5	
	==> Pond inflow from point sources	Qp		[ac-ft]		-	-	-	-	
	Total pond inflow	Qi		[ac-ft]		222.7	71.5	104.3	609.4	
Concentrations	==> Inflow concentration of runoff	Pr		[ug/L]		300	300	300	300	
	Inflow concentration from upstream pond	Pus		[ug/L]		-	-	-	150	
	==> Inflow concentration from point sources	Pp		[ug/L]		-	-	-	-	
Inflow Loads	Pond load from runoff	Lr		[lb]		181.3	58.2	84.9	171.7	496
	Pond load from upstream pond	Lus		[lb]		-	-	-	161.8	
	Pond load from point sources	Lp		[lb]		-	-	-	-	
	Total load to pond	Li		[lb]		181.3	58.2	84.9	333.6	
Model Input	Average pond inflow concentration	Pi		[ug/L]		300	300	300	202	
	==> Inflow Ortho P : Total P ratio	Fo		[--]		0.26	0.26	0.26	0.26	
	Hydraulic residence time	Tr		[yr]		0.045	0.045	0.045	0.016	
		Tr		[d]		16.5	16.4	16.4	6.0	
	Mean surface overflow rate	Qs		[ft/yr]		102.6	89.1	93.3	292.4	
	==> Relative decay rate	[--]		[--]		1	1	1	1	
Model Calculations	Second order decay rate coefficient	K2		[m^3/mg/yr]		0.151	0.145	0.147	0.187	
	Dimensionless reaction rate	Nr		[--]		2.05	1.95	1.98	0.62	
	Fraction of inflow P removed	Rp		[--]		50%	50%	50%	30%	
	Outflow load as percent of inflow load	1 - Rp		[--]		50%	50%	50%	70%	
Pond Performance	Phosphorus load removal			[lb]		91.4	28.8	42.3	100.8	263
	Phosphorus load removal			[--]		50%	50%	50%	30%	53%
	Outflow phosphorus load			[lb]		89.9	29.4	42.6	232.8	233
	Outflow phosphorus load			[--]		50%	50%	50%	70%	47%
	Outflow phosphorus concentration			[ug/L]		149	151	150	141	

Model Case	Panzer Pond		==>	Evaluation Period	240 : [d]	[d]	Whole
				Evaluation Period	0.66 [yr]	[yr]	System
	Input			Volume Reduction due to Sedimentation:	20%		
				Remaining Volume	80%		
	Modeled Total Phosphorus Removal for Total Pond System:				**50.3% [--]**	[--]	
Pond Size	Cell No.			**Cell 1**		**Cell 5**	
	==> Name or Description		[--]	West Pond		Almaz	
	Potential Area	Ap	[ac]				
	==> Pond Surface Area	Ap	[ac]	6.30		3.17	
	Pond Avg Depth before Sedimentation	D	[ft]	5.40		6.00	
	==> Pond Avg Depth (After Sedimentation)	D	[ft]	4.32		4.80	
	Pond Volume (Before Sedimentation)	V	[ac-ft]	34.0		19.0	
	Pond Volume (After Sedimentation)	V	[ac-ft]	27.22		15.22	
Inflows	==> Runoff from 2.5 inch event	Aws	[ac]	30.0		22.0	
	==> Runoff Coefficient (V/P)	C	[ac-ft/in]	12.0		8.8	
	==> Evaluation period precipitation	Pe	[in]	29.3		29.3	
	Pond inflow from runoff	Qr	[ac-ft]	351.6		257.8	
	Pond inflow from upstream pond	Qus	[ac-ft]	-		-	
	==> Pond inflow from point sources	Qp	[ac-ft]	-		-	
	Total pond inflow	Qi	[ac-ft]	351.6		257.8	
Concentrations	==> Inflow concentration of runoff	Pr	[ug/L]	300		300	
	Inflow concentration from upstream pond	Pus	[ug/L]	-		-	
	==> Inflow concentration from point sources	Pp	[ug/L]	-		-	
Inflow Loads	Pond load from runoff	Lr	[lb]	286.2		209.9	496
	Pond load from upstream pond	Lus	[lb]	-		-	
	Pond load from point sources	Lp	[lb]	-		-	
	Total load to pond	Li	[lb]	286.2		209.9	
Model Input	Average pond inflow concentration	Pi	[ug/L]	300		300	
	==> Inflow Ortho P : Total P ratio	Fo	[--]	0.26		0.26	
	Hydraulic residence time	Tr	[yr]	0.051		0.039	
		Tr	[d]	18.6		14.2	
	Mean surface overflow rate	Qs	[ft/yr]	84.9		123.7	
	==> Relative decay rate	[--]	[--]	1		1	
Model Calculations	Second order decay rate coefficient	K2	[m^3/mg/yr]	0.142		0.159	
	Dimensionless reaction rate	Nr	[--]	2.17		1.85	
	Fraction of inflow P removed	Rp	[--]	51%		49%	
	Outflow load as percent of inflow load	1 - Rp	[--]	49%		51%	
Pond Performance	Phosphorus load removal		[lb]	147.0		102.3	249
	Phosphorus load removal		[--]	51.4%		48.7%	50%
	Outflow phosphorus load		[lb]	139.2		107.6	247
	Outflow phosphorus load		[--]	48.6%		51.3%	49.7%
	Outflow phosphorus concentration		[ug/L]	146		154	

Model Case	Panzer Pond		==>	Evaluation Period	240 [d]	[d]	Whole
				Evaluation Period	0.66 [yr]	[yr]	System
				Volume Reduction due to Sedimentation:	20%		
				Remaining Volume	80%		
	Modeled Total Phosphorus Removal for Total Pond System:				50.2% [--]	[--]	
Pond Size	Cell No.			**Cell 1**		**Cell 5**	
	==> Name or Description		[--]	West Pond		Almaz	
	Potential Area	Ap	[ac]				
	==> Pond Surface Area	Ap	[ac]	6.30		3.17	
	Pond Avg Depth before Sedimentation	D	[ft]	5.40		6.00	
	==> Pond Avg Depth (After Sedimentation)	D	[ft]	4.32		4.80	
	Pond Volume (Before Sedimentation)	V	[ac-ft]	34.0		19.0	
	Pond Volume (After Sedimentation)	V	[ac-ft]	27.22		15.22	
Inflows	==> Runoff from 2.5 inch event	Aws	[ac]	29.0		23.0	
	==> Runoff Coefficient (V/P)	C	[ac-ft/in]	11.6		9.2	
	==> Evaluation period precipitation	Pe	[in]	29.3		29.3	
	Pond inflow from runoff	Qr	[ac-ft]	339.9		269.6	
	Pond inflow from upstream pond	Qus	[ac-ft]	-		-	
	==> Pond inflow from point sources	Qp	[ac-ft]	-		-	
	Total pond inflow	Qi	[ac-ft]	339.9		269.6	
Concentrations	==> Inflow concentration of runoff	Pr	[ug/L]	300		300	
	Inflow concentration from upstream pond	Pus	[ug/L]	-		-	
	==> Inflow concentration from point sources	Pp	[ug/L]	-		-	
Inflow Loads	Pond load from runoff	Lr	[lb]	276.7		219.4	496
	Pond load from upstream pond	Lus	[lb]	-		-	
	Pond load from point sources	Lp	[lb]	-		-	
	Total load to pond	Li	[lb]	276.7		219.4	
Model Input	Average pond inflow concentration	Pi	[ug/L]	300		300	
	==> Inflow Ortho P : Total P ratio	Fo	[--]	0.26		0.26	
	Hydraulic residence time	Tr	[yr]	0.053		0.037	
		Tr	[d]	19.2		13.5	
	Mean surface overflow rate	Qs	[ft/yr]	82.0		129.3	
	==> Relative decay rate	[--]	[--]	1		1	
Model Calculations	Second order decay rate coefficient	K2	[m^3/mg/yr]	0.141		0.161	
	Dimensionless reaction rate	Nr	[--]	2.22		1.79	
	Fraction of inflow P removed	Rp	[--]	52%		48%	
	Outflow load as percent of inflow load	1 - Rp	[--]	48%		52%	
Pond Performance	Phosphorus load removal		[lb]	143.2		105.7	249
	Phosphorus load removal		[--]	51.7%		48.2%	50%
	Outflow phosphorus load		[lb]	133.5		113.7	247
	Outflow phosphorus load		[--]	48.3%		51.8%	49.6%
	Outflow phosphorus concentration		[ug/L]	145		155	

Model Case	Panzer Pond		==>	Evaluation Period	240 [d]	[d]	Whole
				Evaluation Period	0.66 [yr]	[yr]	System
	Input			Volume Reduction due to Sedimentation:	20%		
				Remaining Volume	80%		
	Modeled Total Phosphorus Removal for Total Pond System:				**51.0% [--]**	[--]	
Pond Size	Cell No.			**Cell 1**		**Cell 5**	
	==> Name or Description		[--]	I-35W		Almaz	
	Potential Area	Ap	[ac]				
	==> Pond Surface Area	Ap	[ac]	7.00		3.17	
	Pond Avg Depth before Sedimentation	D	[ft]	5.40		6.00	
	==> Pond Avg Depth (After Sedimentation)	D	[ft]	4.32		4.80	
	Pond Volume (Before Sedimentation)	V	[ac-ft]	37.8		19.0	
	Pond Volume (After Sedimentation)	V	[ac-ft]	30.24		15.22	
Inflows	==> Runoff from 2.5 inch event	Aws	[ac]	38.0		14.0	
	==> Runoff Coefficient (V/P)	C	[ac-ft/in]	15.2		5.6	
	==> Evaluation period precipitation	Pe	[in]	29.3		29.3	
	Pond inflow from runoff	Qr	[ac-ft]	445.4		164.1	
	Pond inflow from upstream pond	Qus	[ac-ft]	-		-	
	==> Pond inflow from point sources	Qp	[ac-ft]	-		-	
	Total pond inflow	Qi	[ac-ft]	445.4		164.1	
Concentrations	==> Inflow concentration of runoff	Pr	[ug/L]	300		300	
	Inflow concentration from upstream pond	Pus	[ug/L]	-		-	-
	==> Inflow concentration from point sources	Pp	[ug/L]	-		-	
Inflow Loads	Pond load from runoff	Lr	[lb]	362.6		133.6	496
	Pond load from upstream pond	Lus	[lb]	-		-	
	Pond load from point sources	Lp	[lb]	-		-	
	Total load to pond	Li	[lb]	362.6		133.6	
Model Input	Average pond inflow concentration	Pi	[ug/L]	300		300	
	==> Inflow Ortho P : Total P ratio	Fo	[--]	0.26		0.26	
	Hydraulic residence time	Tr	[yr]	0.045		0.061	
		Tr	[d]	16.3		22.3	
	Mean surface overflow rate	Qs	[ft/yr]	96.8		78.7	
	==> Relative decay rate	[--]	[--]	1		1	
Model Calculations	Second order decay rate coefficient	K2	[m^3/mg/yr]	0.148		0.139	
	Dimensionless reaction rate	Nr	[--]	1.99		2.54	
	Fraction of Inflow P removed	Rp	[--]	50%		54%	
	Outflow load as percent of inflow load	1 - Rp	[--]	50%		46%	
Pond Performance	Phosphorus load removal		[lb]	180.9		72.0	253
	Phosphorus load removal		[--]	49.9%		53.9%	51%
	Outflow phosphorus load		[lb]	181.6		61.6	243
	Outflow phosphorus load		[--]	50.1%		46.1%	49.0%
	Outflow phosphorus concentration		[ug/L]	150		138	

Model Case	Panzer Pond		==>	Evaluation Period	240 [d]	[d]	Whole
				Evaluation Period	0.66 [yr]	[yr]	System
				Volume Reduction due to Sedimentation:	20%		
				Remaining Volume	80%		
				Modeled Total Phosphorus Removal for Total Pond System:	**50.1% [--]**	[--]	
Pond Size	Cell No.			**Cell 1**		**Cell 5**	
	==> Name or Description		[--]	I-35W		Almaz	
	Potential Area	Ap	[ac]				
	==> Pond Surface Area	Ap	[ac]	6.30		3.17	
	Pond Avg Depth before Sedimentation	D	[ft]	5.40		6.00	
	==> Pond Avg Depth (After Sedimentation)	D	[ft]	4.32		4.80	
	Pond Volume (Before Sedimentation)	V	[ac-ft]	34.0		19.0	
	Pond Volume (After Sedimentation)	V	[ac-ft]	27.22		15.22	
Inflows	==> Runoff from 2.5 inch event	Aws	[ac]	38.0		14.0	
	==> Runoff Coefficient (V/P)	C	[ac-ft/in]	15.2		5.6	
	==> Evaluation period precipitation	Pe	[in]	29.3		29.3	
	Pond inflow from runoff	Qr	[ac-ft]	445.4		164.1	
	Pond inflow from upstream pond	Qus	[ac-ft]	-		-	
	==> Pond inflow from point sources	Qp	[ac-ft]	-		-	
	Total pond inflow	Qi	[ac-ft]	445.4		164.1	
Concentrations	==> Inflow concentration of runoff	Pr	[ug/L]	300		300	
	Inflow concentration from upstream pond	Pus	[ug/L]	-		-	
	==> Inflow concentration from point sources	Pp	[ug/L]	-		-	
Inflow Loads	Pond load from runoff	Lr	[lb]	362.6		133.6	496
	Pond load from upstream pond	Lus	[lb]	-		-	
	Pond load from point sources	Lp	[lb]	-		-	
	Total load to pond	Li	[lb]	362.6		133.6	
Model Input	Average pond inflow concentration	Pi	[ug/L]	300		300	
	==> Inflow Ortho P : Total P ratio	Fo	[--]	0.26		0.26	
	Hydraulic residence time	Tr	[yr]	0.040		0.061	
		Tr	[d]	14.7		22.3	
	Mean surface overflow rate	Qs	[ft/yr]	107.5		78.7	
	==> Relative decay rate	[--]	[--]	1		1	
Model Calculations	Second order decay rate coefficient	K2	[m^3/mg/yr]	0.153		0.139	
	Dimensionless reaction rate	Nr	[--]	1.85		2.54	
	Fraction of inflow P removed	Rp	[--]	49%		54%	
	Outflow load as percent of inflow load	1 - Rp	[--]	51%		46%	
Pond Performance	Phosphorus load removal		[lb]	176.5		72.0	248
	Phosphorus load removal		[--]	48.7%		53.9%	50%
	Outflow phosphorus load		[lb]	186.1		61.6	248
	Outflow phosphorus load		[--]	51.3%		46.1%	49.9%
	Outflow phosphorus concentration		[ug/L]	154		138	

Model Case	Input	Panzer Pond		==>	Evaluation Period	240 [d]	[d] / [yr]	Whole System
					Evaluation Period	0.66 [yr]		
					Volume Reduction due to Sedimentation:	20%		
					Remaining Volume	80%		
		Modeled Total Phosphorus Removal for Total Pond System:				46.8% [--]	[--]	
Pond Size		Cell No.			**Cell 1**		**Cell 5**	
	==>	Name or Description		[--]	West Pond		Almaz	
		Potential Area	Ap	[ac]				
	==>	Pond Surface Area	Ap	[ac]	6.10		3.17	
		Pond Avg Depth before Sedimentation	D	[ft]	5.43		6.00	
	==>	Pond Avg Depth (After Sedimentation)	D	[ft]	4.34		4.80	
		Pond Volume (Before Sedimentation)	V	[ac-ft]	33.1		19.0	52
		Pond Volume (After Sedimentation)	V	[ac-ft]	26.50		15.22	42
Inflows	==>	Runoff from 2.5 inch event	Aws	[ac]	16.0		36.0	52
	==>	Runoff Coefficient (V/P)	C	[ac-ft/in]	6.4		14.4	
	==>	Evaluation period precipitation	Pe	[in]	29.3		29.3	
		Pond inflow from runoff	Qr	[ac-ft]	187.5		421.9	
		Pond inflow from upstream pond	Qus	[ac-ft]	-		-	
	==>	Pond inflow from point sources	Qp	[ac-ft]	-		-	
		Total pond inflow	Qi	[ac-ft]	187.5		421.9	
Concentrations	==>	Inflow concentration of runoff	Pr	[ug/L]	300		300	
		Inflow concentration from upstream pond	Pus	[ug/L]	-		-	
	==>	Inflow concentration from point sources	Pp	[ug/L]	-		-	
Inflow Loads		Pond load from runoff	Lr	[lb]	152.7		343.5	496
		Pond load from upstream pond	Lus	[lb]	-		-	
		Pond load from point sources	Lp	[lb]	-		-	
		Total load to pond	Li	[lb]	152.7		343.5	
Model Input		Average pond inflow concentration	Pi	[ug/L]	300		300	
	==>	Inflow Ortho P : Total P ratio	Fo	[--]	0.26		0.26	
		Hydraulic residence time	Tr	[yr]	0.093		0.024	
			Tr	[d]	33.9		8.7	
		Mean surface overflow rate	Qs	[ft/yr]	46.8		202.4	
	==>	Relative decay rate	[--]	[--]	1		1	
Model Calculations		Second order decay rate coefficient	K2	[m^3/mg/yr]	0.111		0.177	
		Dimensionless reaction rate	Nr	[--]	3.11		1.26	
		Fraction of Inflow P removed	Rp	[--]	57%		42%	
		Outflow load as percent of inflow load	1 - Rp	[--]	43%		58%	
Pond Performance		Phosphorus load removal		[lb]	87.2		144.8	232
		Phosphorus load removal		[--]	57.1%		42.2%	47%
		Outflow phosphorus load		[lb]	65.5		198.7	264
		Outflow phosphorus load		[--]	42.9%		57.8%	53.2%
		Outflow phosphorus concentration		[ug/L]	129		174	

Model Case	Panzer Pond			==> Evaluation Period	240 [d]	[d]	Whole
				Evaluation Period	0.66 [yr]	[yr]	System
				Volume Reduction due to Sedimentation:	0%		
				Remaining Volume	100%		
	Modeled Total Phosphorus Removal for Total Pond System:				50.5% [--]	[--]	
Pond Size	Cell No.			**Cell 1**		**Cell 5**	
	==> Name or Description		[--]	West Pond		Almaz	
	Potential Area	Ap	[ac]				
	==> Pond Surface Area	Ap	[ac]	6.10		3.17	
	Pond Avg Depth before Sedimentation	D	[ft]	5.43		6.00	
	==> Pond Avg Depth (After Sedimentation)	D	[ft]	5.43		6.00	
	Pond Volume (Before Sedimentation)	V	[ac-ft]	33.1		19.0	52
	Pond Volume (After Sedimentation)	V	[ac-ft]	33.1		19.0	52
Inflows	==> Runoff from 2.5 inch event	Aws	[ac]	16.0		36.0	52
	==> Runoff Coefficient (V/P)	C	[ac-ft/in]	6.4		14.4	
	==> Evaluation period precipitation	Pe	[in]	29.3		29.3	
	Pond Inflow from runoff	Qr	[ac-ft]	187.5		421.9	
	Pond Inflow from upstream pond	Qus	[ac-ft]	-		-	
	==> Pond Inflow from point sources	Qp	[ac-ft]	-		-	
	Total pond inflow	Qi	[ac-ft]	187.5		421.9	
Concentrations	==> Inflow concentration of runoff	Pr	[ug/L]	300		300	
	Inflow concentration from upstream pond	Pus	[ug/L]	-		-	
	==> Inflow concentration from point sources	Pp	[ug/L]	-		-	
Inflow Loads	Pond load from runoff	Lr	[lb]	152.7		343.5	496
	Pond load from upstream pond	Lus	[lb]	-		-	
	Pond load from point sources	Lp	[lb]	-		-	
	Total load to pond	Li	[lb]	152.7		343.5	
Model Input	Average pond inflow concentration	Pi	[ug/L]	300		300	
	==> Inflow Ortho P : Total P ratio	Fo	[--]	0.26		0.26	
	Hydraulic residence time	Tr	[yr]	0.116		0.030	
		Tr	[d]	42.4		10.8	
	Mean surface overflow rate	Qs	[ft/yr]	46.8		202.4	
	==> Relative decay rate	[--]	[--]	1		1	
Model Calculations	Second order decay rate coefficient	K2	[m^3/mg/yr]	0.111		0.177	
	Dimensionless reaction rate	Nr	[--]	3.88		1.58	
	Fraction of inflow P removed	Rp	[--]	61%		46%	
	Outflow load as percent of inflow load	1 - Rp	[--]	39%		54%	
Pond Performance	Phosphorus load removal		[lb]	92.4		157.9	250
	Phosphorus load removal		[--]	60.5%		46.0%	50%
	Outflow phosphorus load		[lb]	60.3		185.5	246
	Outflow phosphorus load		[--]	39.5%		54.0%	49.5%
	Outflow phosphorus concentration		[ug/L]	118		162	

Stanley Consultants INC.

MEETING NOTES

No. 006

Date: 26 April 2007

Place: Mn/DOT – Waters Edge

Project/Purpose: I-494 Stormwater Alternatives

Attendees:
Beth Neuendorf, Mn/DOT WRE
Nicole Rosen, Mn/DOT Design
Scott Pedersen, Mn/DOT West Metro
Andrea Hendrickson, Mn/DOT Hydraulics Bridge
Debra Anderson, Mn/DOT R/W
Bev Farraher, Mn/DOT Maintenance
Hailu Shekur, Mn/DOT WRE
David Hagle, Mn/DOT Maintenance
Scott Carlstrom, Mn/DOT WRE
Gerry Bergeson, Cedar TS Maintenance
John Thene, Wenck Associates, Inc. (Wenck)
Alan Palmer, Stanley Consultants, Inc. (Stanley)
Jessica Willey, Stanley Consultants, Inc.

Notes By: Jessica Willey

The following meeting notes set forth our understanding of the discussions and decisions made at this meeting. If you have any questions, additions, or comments, please contact the writer immediately. If we do not hear from you, we will assume that our understandings are the same. We are proceeding based on the contents of these meeting notes.

This purpose of this meeting was to document reactions from the Mn/DOT Functional Groups regarding the I-494 Stormwater Alternatives Study.

Following introductions, Stanley and Wenck gave a presentation which included the history of the project, analysis objectives, analysis preliminaries, hydraulic model and drainage alternatives in detail, cost estimate for each alternative, and general feedback from the Cities of Bloomington and Richfield and the watershed districts of Nine Mile Creek and Lower Minnesota River.

1. The new open ponds shown on some of the alternatives would be used for both water quality and detention storage. They would be wet, with normal water elevation controlled by local groundwater.

2. About 6.2 acres is required at West Pond for water quality storage in Alternatives 1C, 2D, 2E, 2F, and 5A. Even if it was made larger to treat an increase of phosphorus, it would be tough to meet the requirements for removal without new technology. About 60% maximum could be removed with the current technology.

3. There may be the potential for an additional storage area by West Pond (south of West Pond). This would include approximately 18 acres. There is a potential to do a land swap with the Fish and Wildlife Service. Right-of-Way and environmental people would need to be included in these meetings. A number of the Alternatives would benefit from an additional treatment and storage site. Further right-of-way may show up in the future. Mn/DOT should be aware of possibilities in this regard.

4. The Lower MN Watershed has concerns with the outfall by West Pond, especially with regards to navigation, so the outfall may need to be a board weir – say 100-foot – so the discharge is less concentrated on the river.

5. There is currently a berm along the river. Mitigation was done when it was built. Federal money was used for the infiltration wetland with trees. It could be used for treatment or flood storage.

6. Currently, Mn/DOT does not store stormwater under roadways. For this study, this concept is shown to leave open the possibility of stormwater storage under the roadway in the future.

7. The chambers would be used during times of high flow. For permitting purposes, it would need to be determined if these chambers are "ponds" or "special pollution control devices". About 20% of the "ponds" would need to be inspected each year, while the "special pollution control devices" may need to be cleaned out and inspected every year. Actual permitting details would be worked out during the design process.

8. The backflow preventor pipe in the concrete chambers was modeled as a 12-inch pipe, but could be larger. To avoid plugging of this pipe, it could be modeled as a weir. This would be easier to manage and a good back-up.

9. Access to the silt chambers could likely be designed within the roadway shoulders for easier access.

10. Underground storage has been used before, but never under highway pavement. Stanley discussed this with Dan Ghere at the FHWA. Since there is no room within the right-of-way to provide more traditional detention storage basins and right-of-way becomes increasingly expensive, underground storage must eventually be seen as a reasonable detention storage solution. It may not start with this roadway, but it will be used with smaller streets having right-of-way restraints.

11. For Alternative 2F, lowering the groundwater would be permanent if the system is not sealed. Alternative 2F would likely need DNR approval to address potential groundwater concerns. Mn/DOT is concerned with "proving" that the Alternative 2F system remains sealed to groundwater, and that continuous monitoring will be required. Simply dewatering locally and for construction should get DNR approval, but if it were to change the groundwater further away or for longer time frames, approval could be more difficult.

12. Mn/DOT questioned the idea of lining the existing storm sewer system 20 years into the future. They felt that the system would be very old at that point and wondered about what to do with it in the meantime. Will the system be too old at this point to still reuse? All of the alternatives depend on reusing portions of the existing system. This study assumes the existing system will still be useable by the time I-494 is reconstructed. Reconstructing versus relining the existing system will need to be considered when this report is revisited. In this regard, the existing system should be monitored and lined as needed to preserve the pipe for future use. Maintenance reports that portions of the pipe are up to 1/3 full of silt.

13. Mn/DOT maintenance disliked Alternative 2E the most. They felt this was the alternate that was the worst of both worlds with the wet or dry ponds (having to maintain and keep nice) and having new underground storage. They would prefer one or the other. Also, they would like to minimize the number of locations and frequency that they have to maintain the system and maximize the ease of access.

14. None of the Alternative 2's eliminate the pump station at Penn Avenue. Each Alternative provides storage for the design event, such that the roadway would not flood if the storm were accompanied by total pump failure.

15. The property acquisition costs were developed by using twice the Hennepin County valuation (as

recommended by the City of Bloomington) and include loss of tax revenue.

16. Costs for repairs of the retaining walls (a simple barrier at the top) were included under the YR40 Maintenance.

17. Alternative 2F was assumed a non-sealed system for the construction costs. For a system sealed against groundwater infiltration, this may add costs. Stanley will provide these costs in the report. All maintenance costs will be included. For this estimate, it was assumed the system was similar to underground box culverts.

18. The internal Mn/DOT cost on the costs of clean-out of the sediment basins could be provided.

Distribution:

Beth Neuendorf, Mn/DOT
John Thene, Wenck Associates, Inc.
Alan Palmer, Stanley Consultants, Inc.
Jessica Willey, Stanley Consultants, Inc.
File 19636

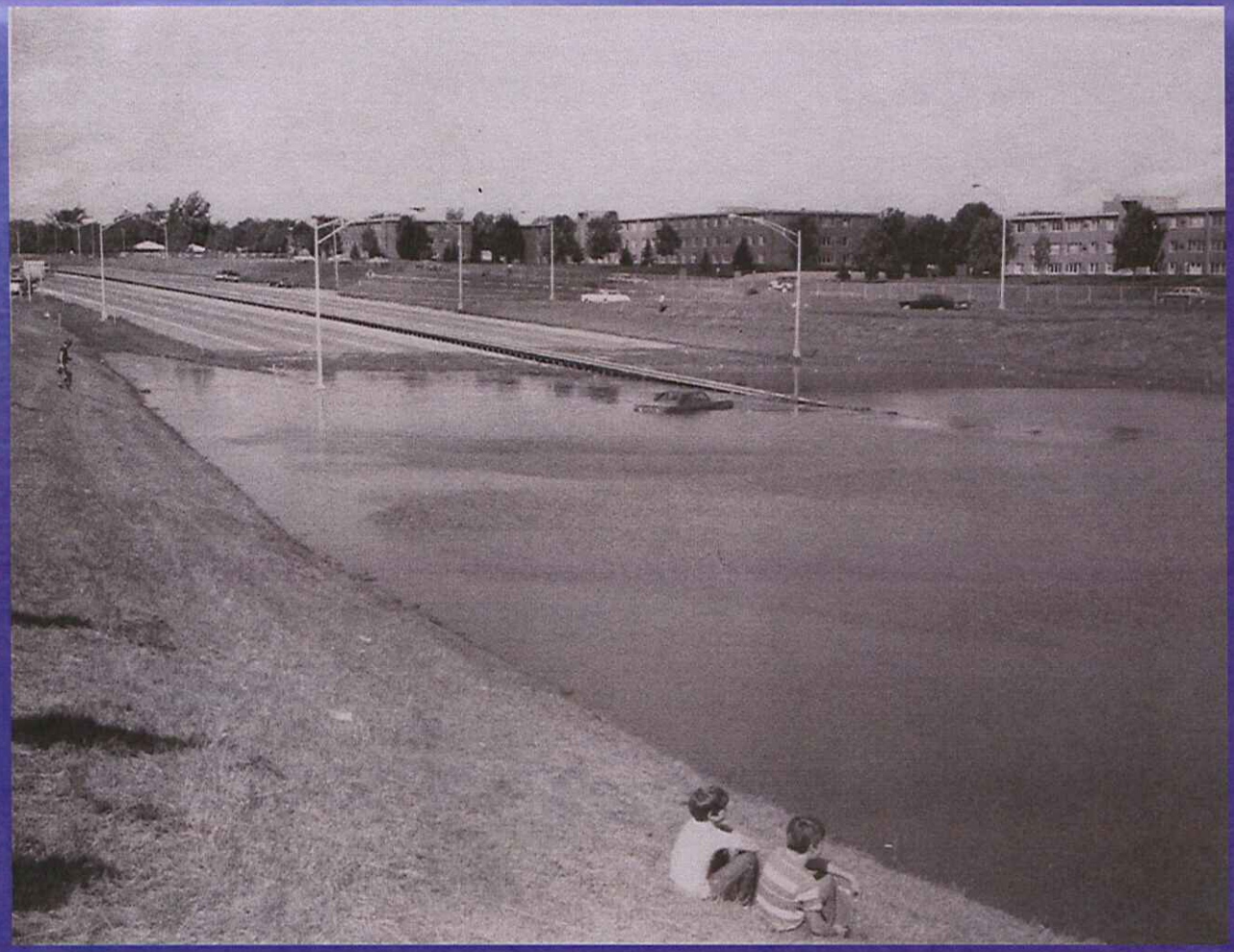
Interstate 494 Stormwater Alternatives

Penn Avenue to the
Minnesota River
26 April 2007

Stanley Consultants, Inc.
Wenck Associates, Inc.

Introduction

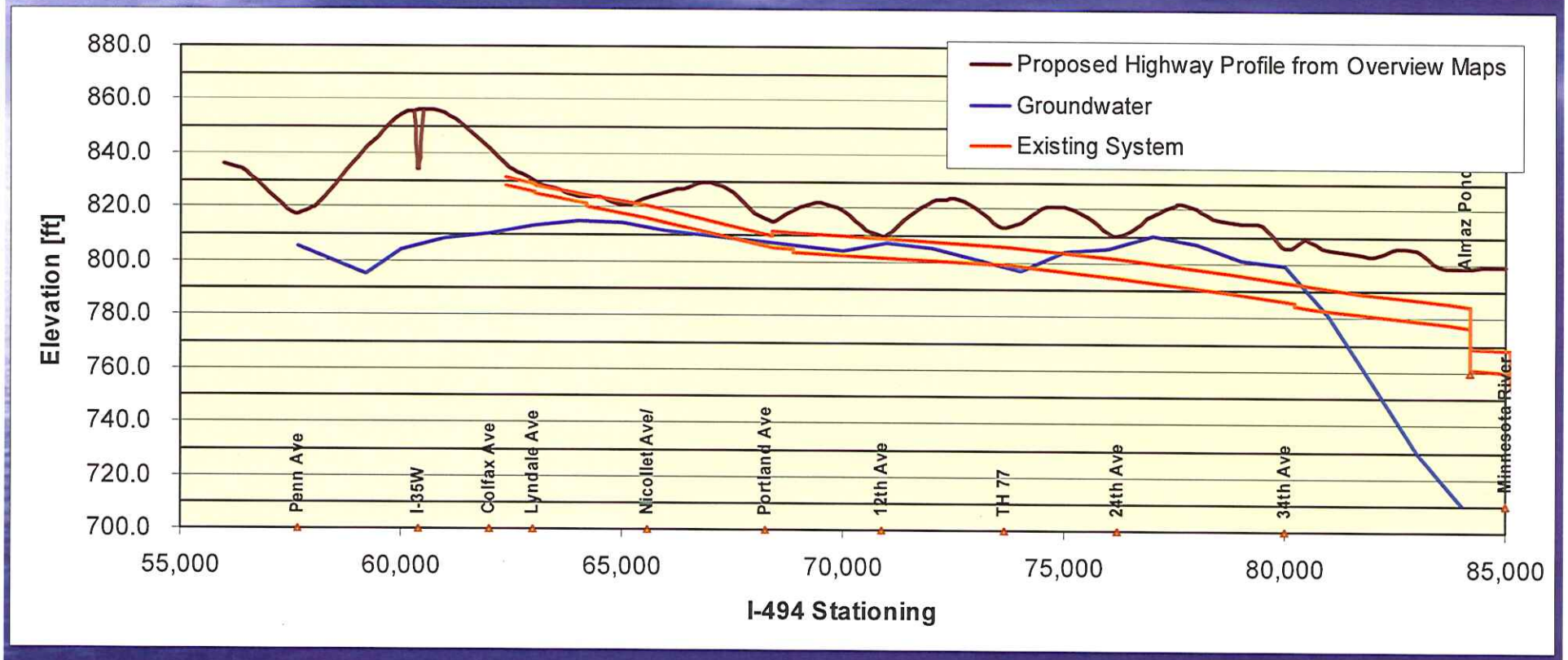
- Project
- History



Introduction

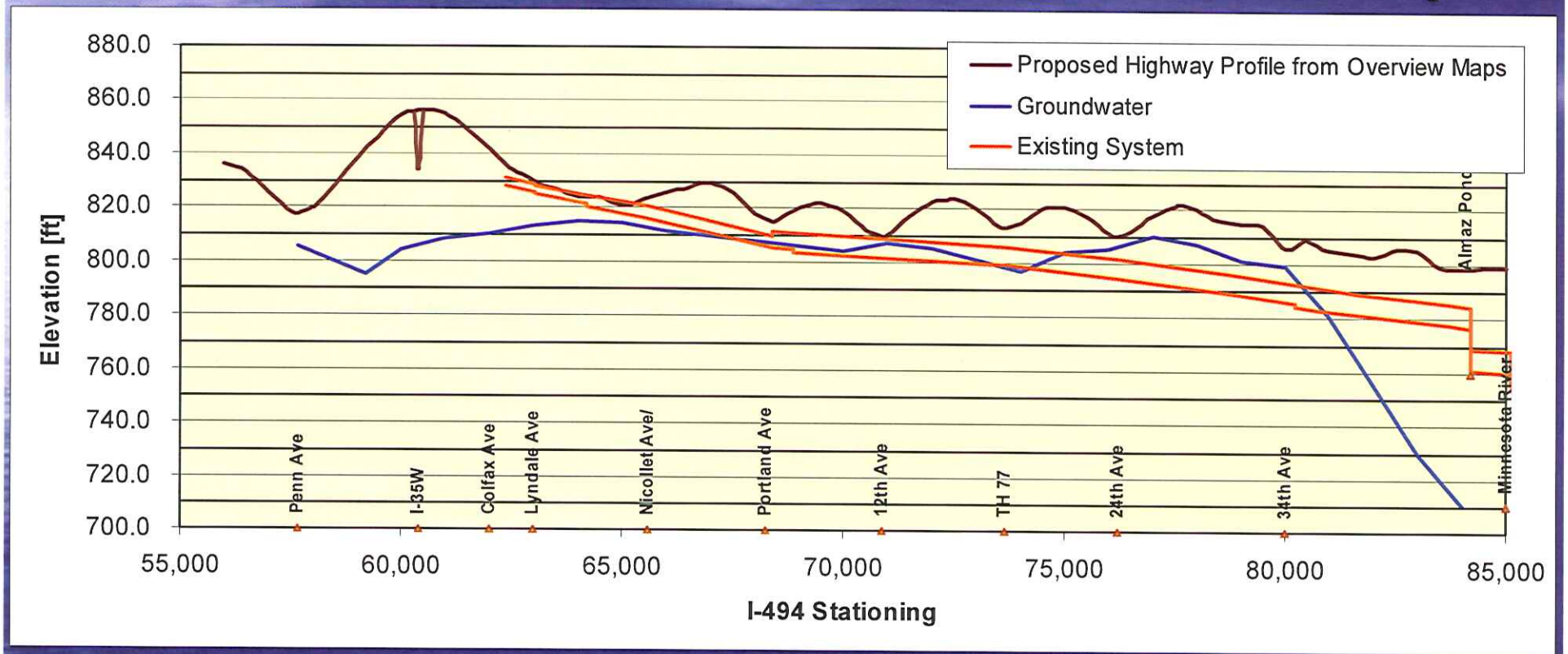
- Project Team
  - Braun Intertec
  - Lyman Henn
  - Wenck Associates
  - Stanley Consultants
- Project Approach
  - Data Collection
  - Stakeholder Meetings
  - Analysis

Existing System



- Surcharges at ~ 5-year event
- Low Point Flooding
- Penn Avenue pumped

Existing System / Future Roadway

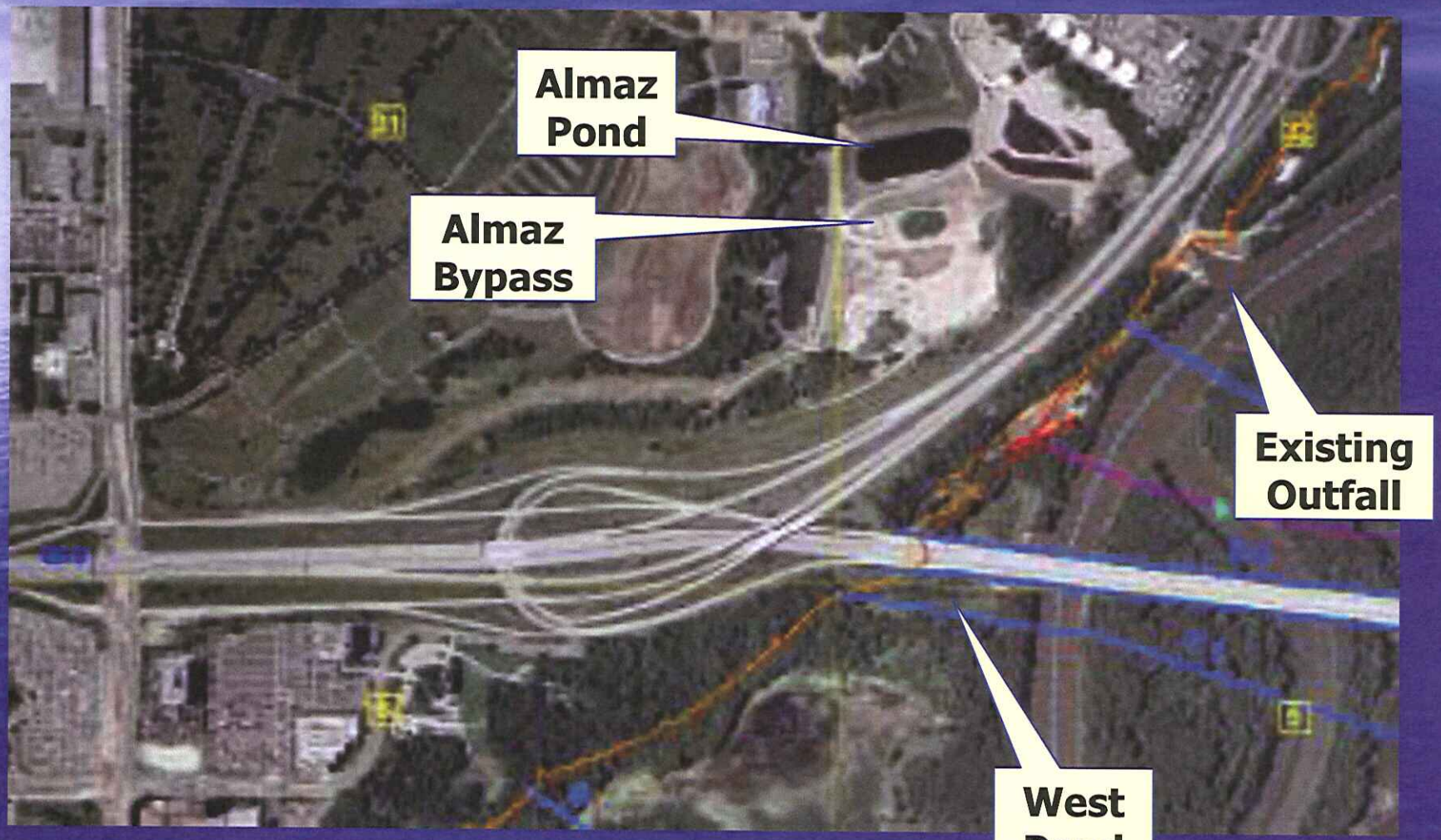


- Future I-494 increases peak discharge by ~80 percent, changes profile
- Existing system can drain TH77 to Minnesota River only

Outfall Locations

- Existing Almaz Pond and Outfall to Minnesota River north of I-494 bridge
- Existing Almaz Bypass and Outfall to Minnesota River
- Expanded West Pond and Outfall to Minnesota River beneath I-494 bridge
- New I-35W Pond and Outfall to Minnesota River near I-35W bridge
- All are within Lower Minnesota River Watershed District and subject to LMRWD Design Guidelines. Requires a LMRWD Permit

Existing Outfall Locations



Conveyance System Analysis

- XP-SWMM Model of Trunk Line and Proposed Facilities
- Developed in I-494 Tunnel Feasibility Study and Reviewed in this Study
- Used to evaluate and design alternatives

XP-SWMM Model

- 438 acres
- 38 subwatersheds
  - Average area: 11.5 ac; Range: 1.4 to 53 ac
- SCS Curve Number
  - Average: 89; Range: 77 to 98
- Time of Concentration
  - Average: 17 min; Range: 7 to 48 min
- 50-year rainfall: 5.3 inches
- 100-year rainfall: 5.9 inches

Design Standards - Rate Control

- LMRWD rules limit proposed discharge to existing for 50- and 100-year events
- Low point flooding in existing system limits existing peak to 470 cfs
- Tunnel option without any storage would have a peak of 1,140 cfs
- With or without rate control, most of the flow will reach the river within five hours

Rate Control – LMRWD Resolution

- Travel time for regional floods: ~ 6 days Montevideo to Savage
- Due to timing of peaks on the river, it is unlikely that detention for two hours and rate control would affect peak water levels and flows on the river
- Presence of a rate control pond near the river could reduce floodplain conveyance
- Poor soils at West Pond site
- <u>No rate control needed for Alt. 1C</u>

Design Standards - Water Quality

- LMRWD Wet Detention Volume equal to runoff from 2.5-inch storm event
- Equivalency determined using PondNet
- Six to eight feet maximum depth
- 3H:1V side slopes
- 10H:1V, 10-ft safety bench

Sedimentation

- Annual runoff volume: 440 ac-ft
  - *Volume determined based on an annual runoff coefficient of 0.4 and precip of 30 inches (runoff coefficient for the 2.5 inch Type II event was 0.57)*
- Average TSS: 300 mg/L (900 lb/ac)
  - *Average TSS was from the Diamond Lake study for monitoring point 2, where the portion of highway corridor in the subwatershed was highest. Rounded up to 300 from the ~236 average of the monitored FWMC of 2004, 2005 and 2006 (74, 254, 381).*
  - *The load was based on the (440 ac-ft/yr)*(300 mg/L)*2.72 = 360,000 lb/yr; or 360,000/440,000 = 816, say 900 lb/ac/yr*
- Annual sediment volume: 5,000 cu ft
  - *Volume: 360,000lb/yr/(80 lb/cu-ft) = 4500 cu ft, say 5,000 cu ft.*
- 2.3 ac-ft over 20 years
- Concern for underground storage

Design Standards - Conveyance

- 50-year event: No surcharging
- 100-year event: No surface flooding
- Pond Normal Water Level: Set at minimum measured groundwater elevation
- Pond Maximum Water Level: Set to meet surcharge requirement or 3.5 feet below the proposed roadway sag elevation
- Ponds not feasible at 12th and 24th Ave.

Existing System / Future Roadway

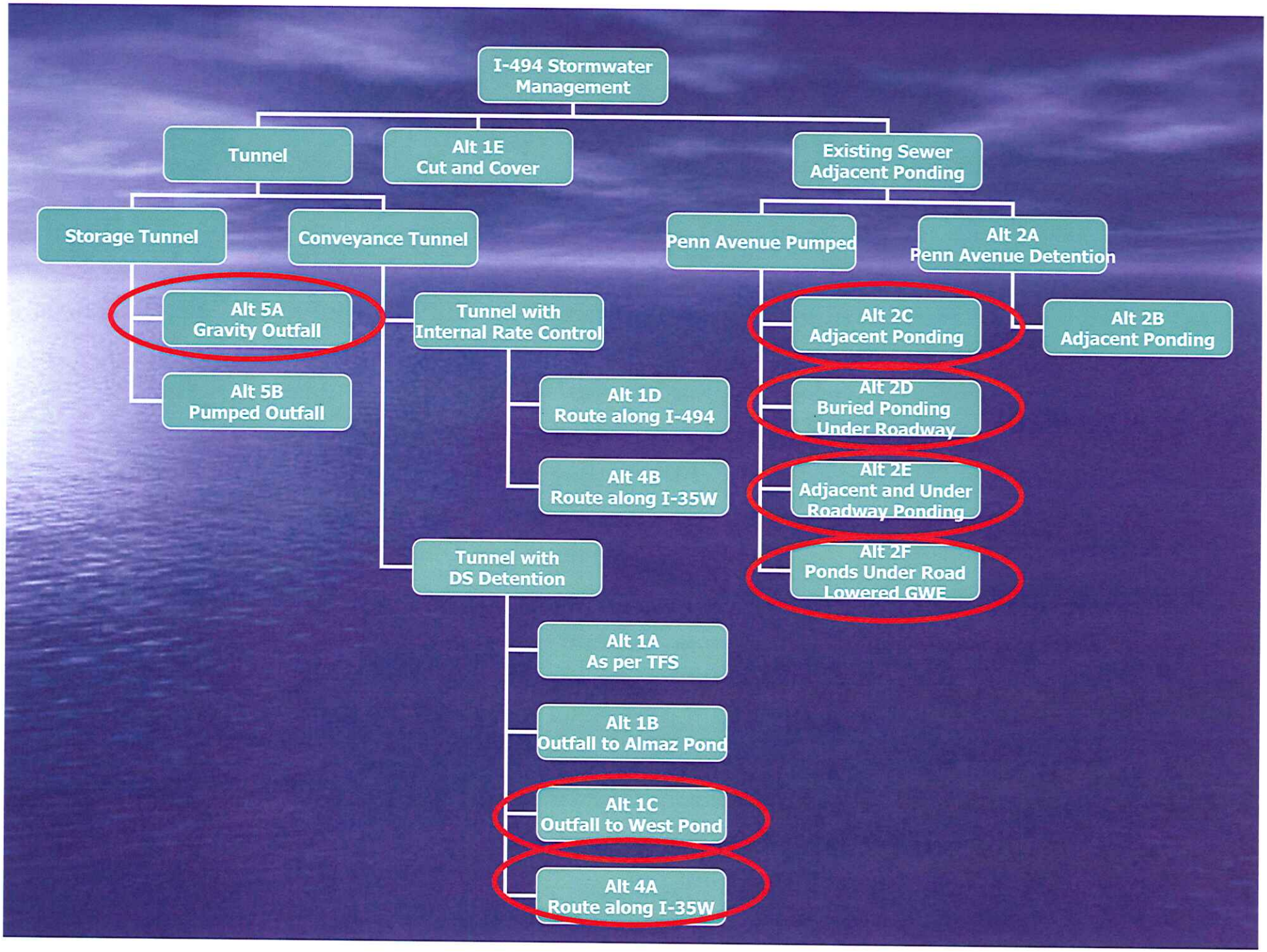
- Future I-494 increases peak discharge by ~80 percent, changes profile
- Existing system can drain TH77 to Minnesota River (with slight surcharging)
- Need new capacity upstream of TH 77 or detention at multiple low points

Existing System / Future Roadway

- Flooded volume in 100-year event: 41 ac-ft
- Water Quality Storage Volume: 52 ac-ft
- Almaz Dead Storage: 19 ac-ft

Alternatives Development

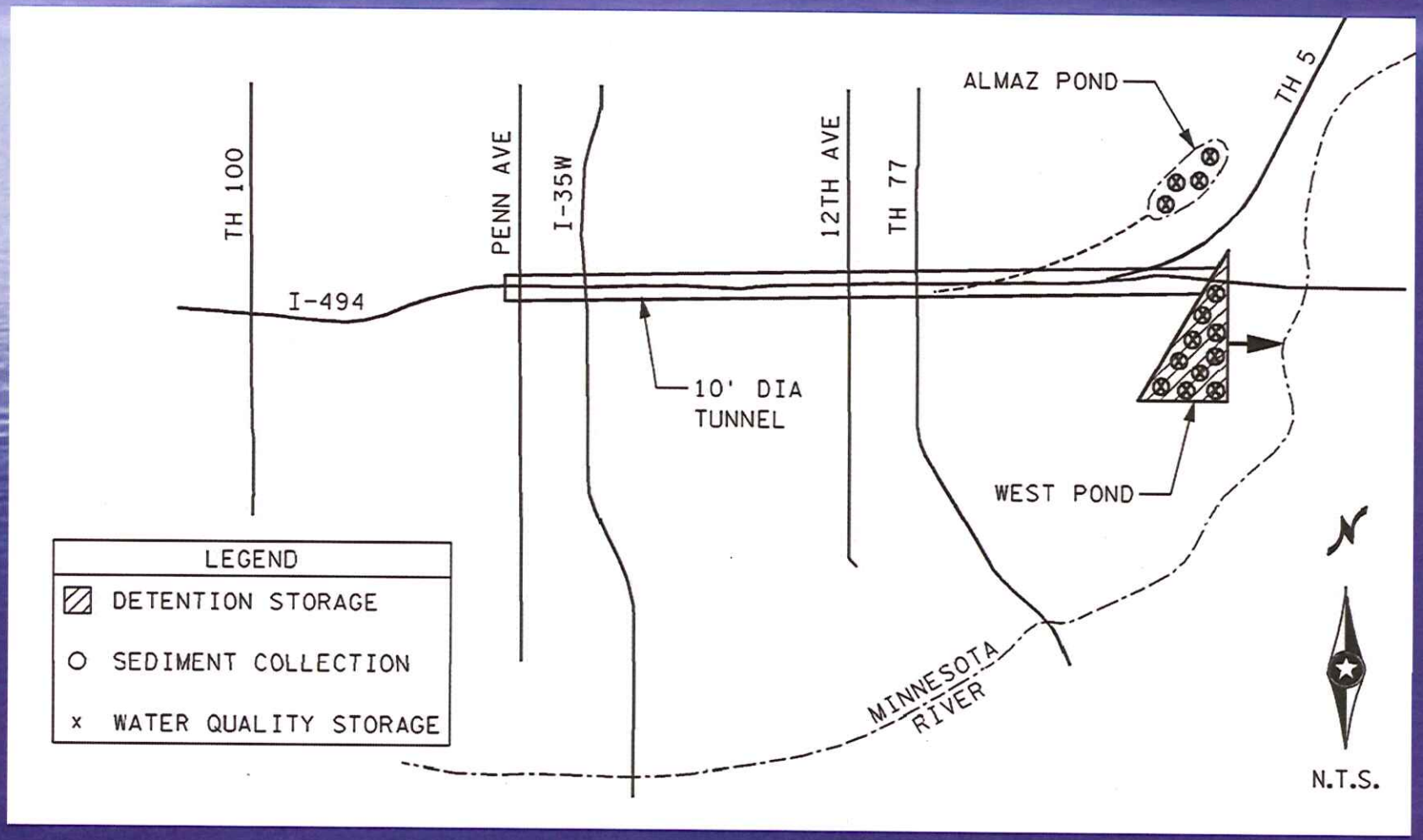
- Traditional Storm Sewer or Tunnel?
- Upstream or Downstream Storage?
- Pumped Conveyance or Gravity?
- In-line Storage or Ponding?
- Route Here or There?


I-494 Stormwater Management
Tunnel
Alt 1E Cut and Cover
Existing Sewer Adjacent Ponding
Storage Tunnel
Conveyance Tunnel
Penn Avenue Pumped
Alt 2A Penn Avenue Detention
Alt 5A Gravity Outfall
Tunnel with Internal Rate Control
Alt 2C Adjacent Ponding
Alt 2B Adjacent Ponding
Alt 5B Pumped Outfall
Alt 1D Route along I-494
Alt 2D Buried Ponding Under Roadway
Alt 4B Route along I-35W
Alt 2E Adjacent and Under Roadway Ponding
Tunnel with DS Detention
Alt 2F Ponds Under Road Lowered GWE
Alt 1A As per TFS
Alt 1B Outfall to Almaz Pond
Alt 1C Outfall to West Pond
Alt 4A Route along I-35W

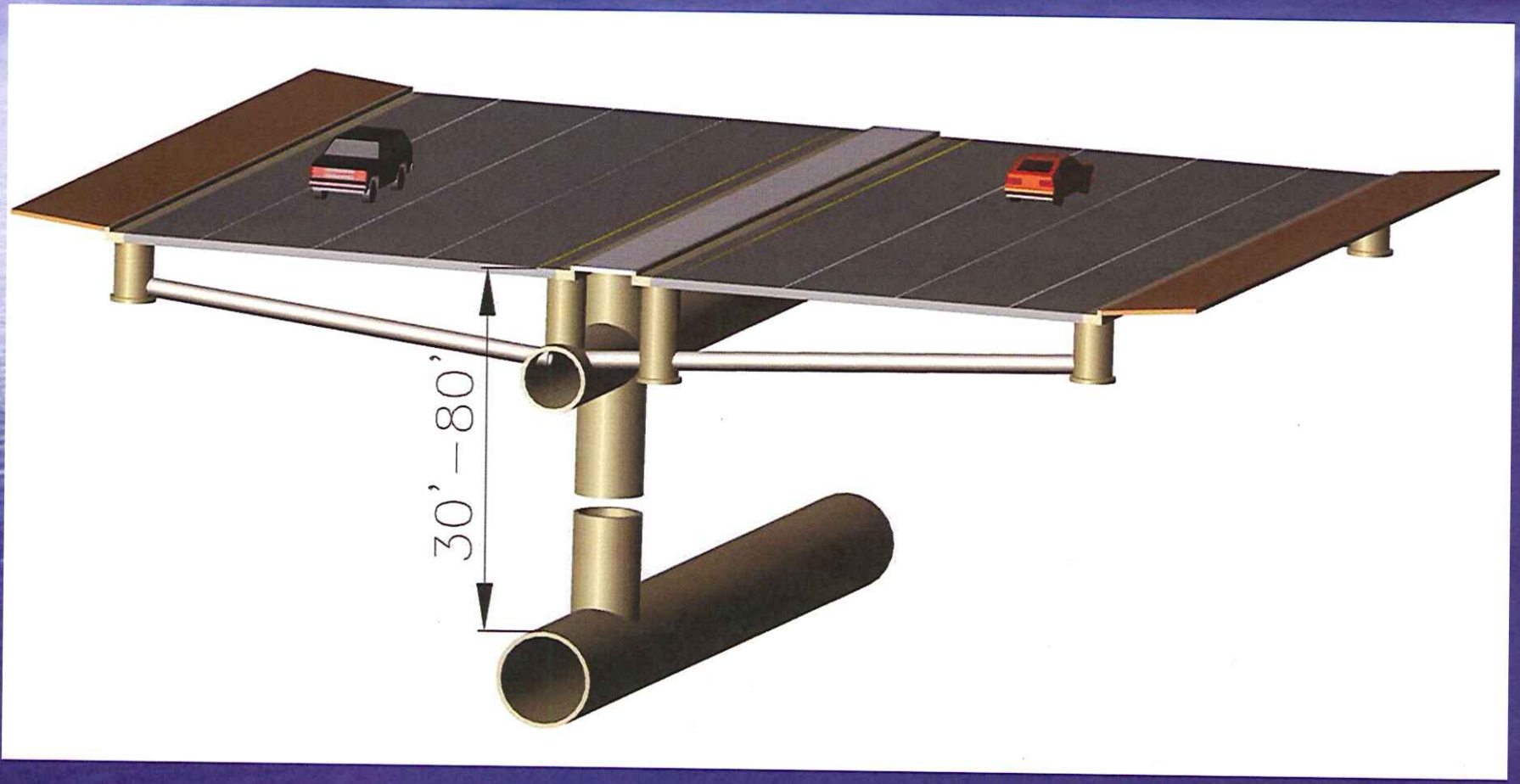
Alternative Refinement

- 1C – Conveyance Tunnel
- 2C – Existing Sewer, Adjacent Ponding
- 2D – Existing sewer, Buried Ponding Under Roadway
- 2E – Existing Sewer, Adjacent and Under-roadway Ponding
- 2F – Existing Sewer, Buried Ponding, Sealed System (Lowered Groundwater)
- 4A – Conveyance Tunnel, I-35W
- 5A – Storage Tunnel with Gravity Outfall

Alternative 1C – 10′ Conveyance Tunnel with Downstream Detention



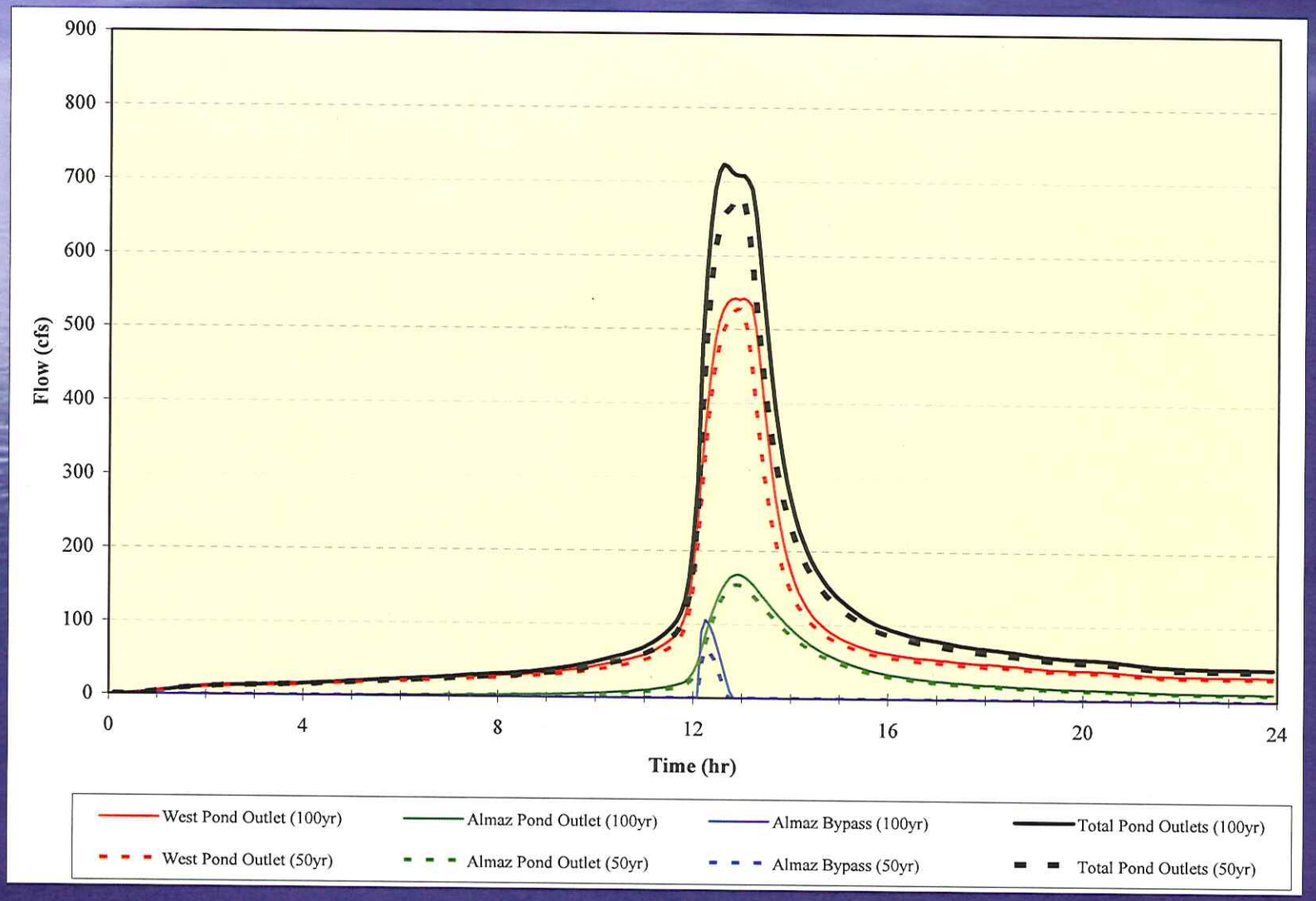
Tunnel Alternatives



Alternative 1C

- Outfall: Almaz, Almaz Bypass, West Pond
- 10-ft Tunnel, Penn to West Pond
- Earth-pressure-balanced construction
- Segmental concrete-lined, water-tight
- Vortex drop shafts at Penn, Wentworth, Portland and TH 77
- No rate control per LMRWD resolution
- WQ: 38 ac-ft at West Pond over 6.2 acres
- Continue to use Almaz
- Sediment accumulation in ponds

Alternative 1C

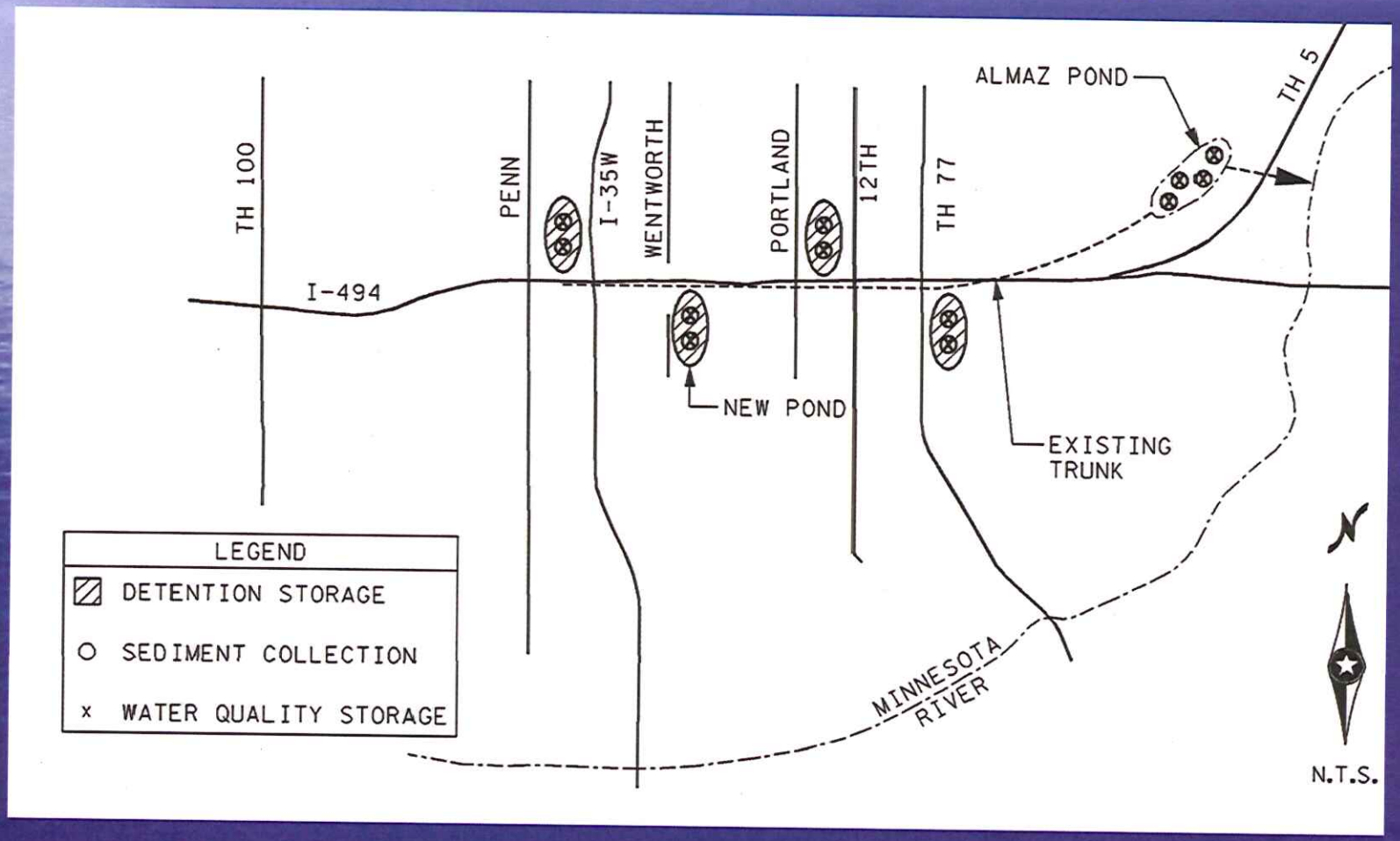


Alternative 1C

- Construction Cost $126.0M
- Property Costs $ 0.9M
- Maintenance Costs $ 0.4M
- Reconstruction (YR40) $ 4.0M

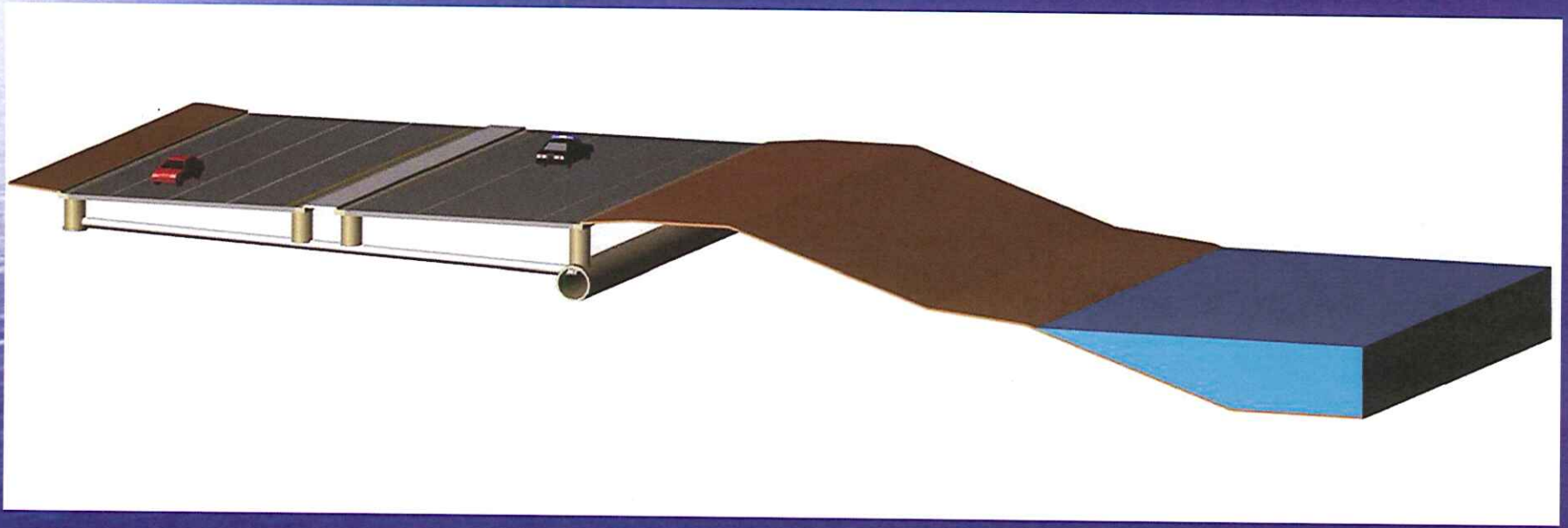
- Life Cycle Cost (80YR) $131.4M

Alternative 2C – Reuse Existing Storm Sewer System with Adjacent Above Ground Ponding



Inplace Storm Sewer

Storage Pond – 3:1 slopes



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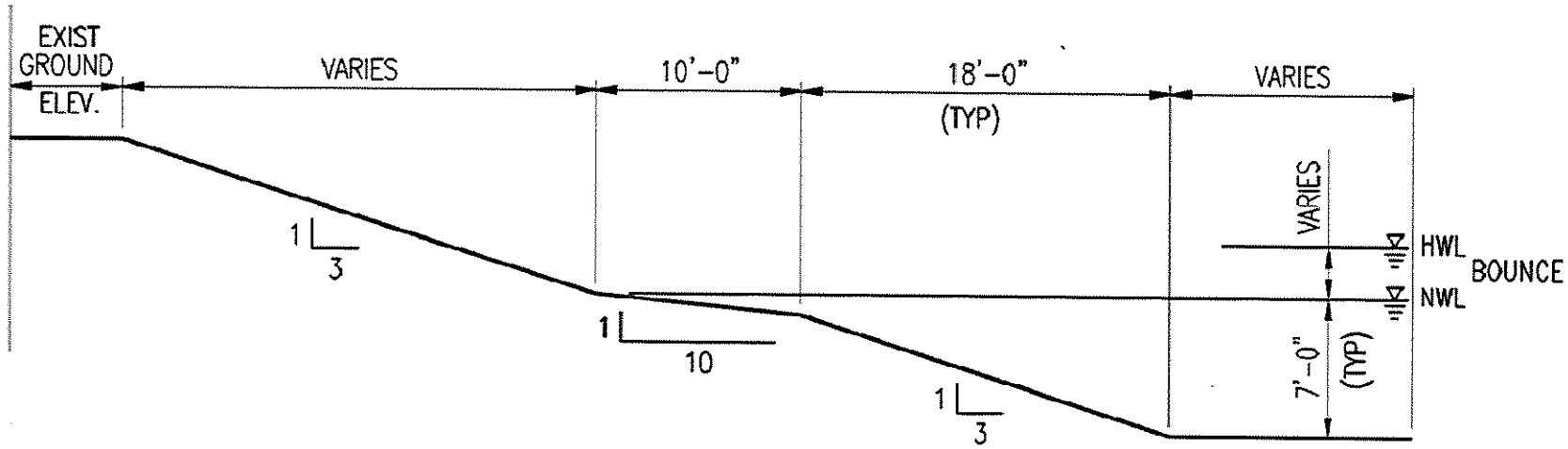

LOCATION	GROUND ELEVATION	GROUNDWATER TABLE	EXISTING SYSTEM INVERT	BOUNCE (ft)	
PENN AVE.	830	811.2	811.8	3.6	
WENTWORTH AVE.	840	811.1	811.5	6.2	
PORTLAND AVE.	830	809.8	805.1	1.3	
TH 77	825	804.2	799.0	1.7	

FIGURE 02
TRADITIONAL CUT POND
I-494 STORMWATER ALTERNATIVES STUDY

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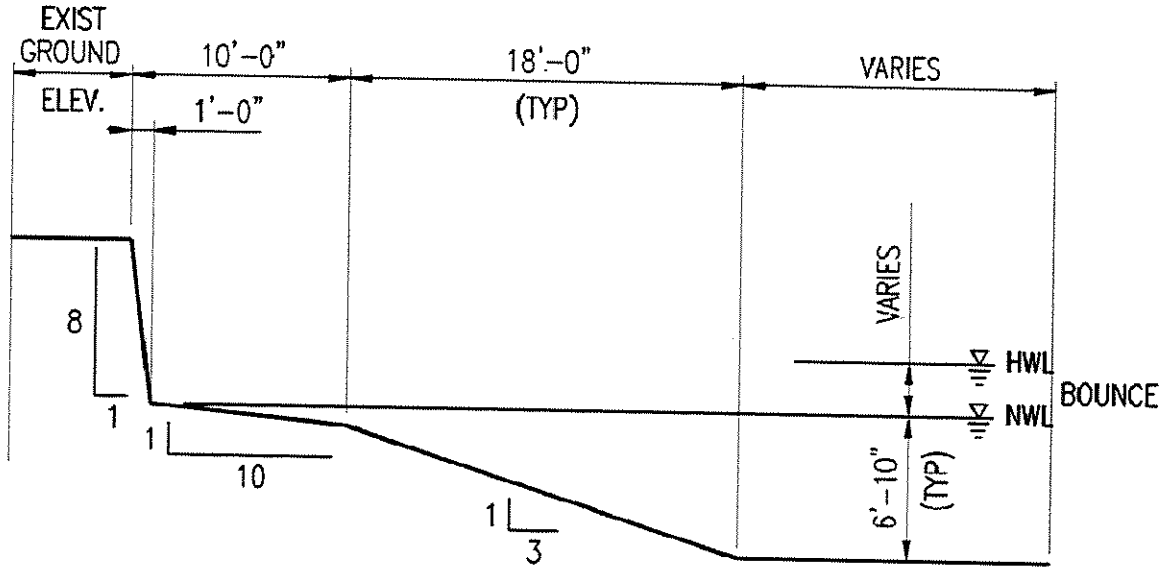


LOCATION	GROUND ELEVATION	GROUNDWATER TABLE	EXISTING SYSTEM INVERT	BOUNCE (ft)
PENN AVE.	830	811.2	811.8	3.6
WENTWORTH AVE.	840	811.1	811.5	6.2
PORTLAND AVE.	830	809.8	805.1	1.3
TH 77	825	804.2	799.0	1.7

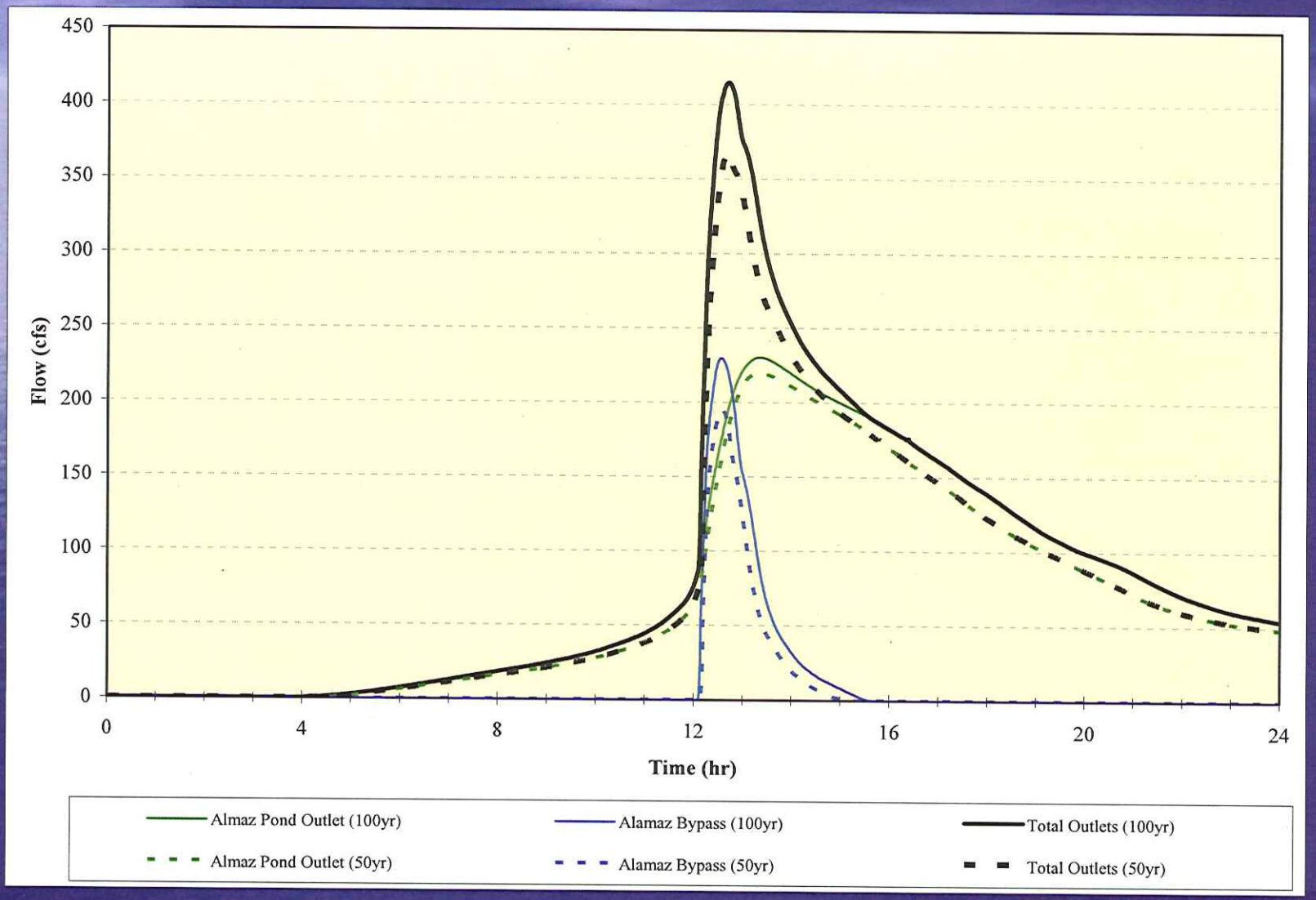
FIGURE 03
MODIFIED POND
I-494 STORMWATER ALTERNATIVES STUDY

Storage Pond – 1:8 slopes (MSE)

Alternative 2C

- Outfall: Almaz, Almaz Bypass
- Surface ponds at Penn, Wentworth, Portland and TH 77
- Penn – volume for 100-year runoff; pumped over 24 hours to Colfax (4,000 ft). *Colfax Avenue is the upstream extent of the trunk sewer system modeled for the project. It is the first collection point east of I-35W.*
- Wentworth – in-line
- Portland – intervening flow to low point
- TH 77 – intervening flow to low point
- WQ - incorporated into surface ponds
- Sediment accumulation in ponds

Alternative 2C

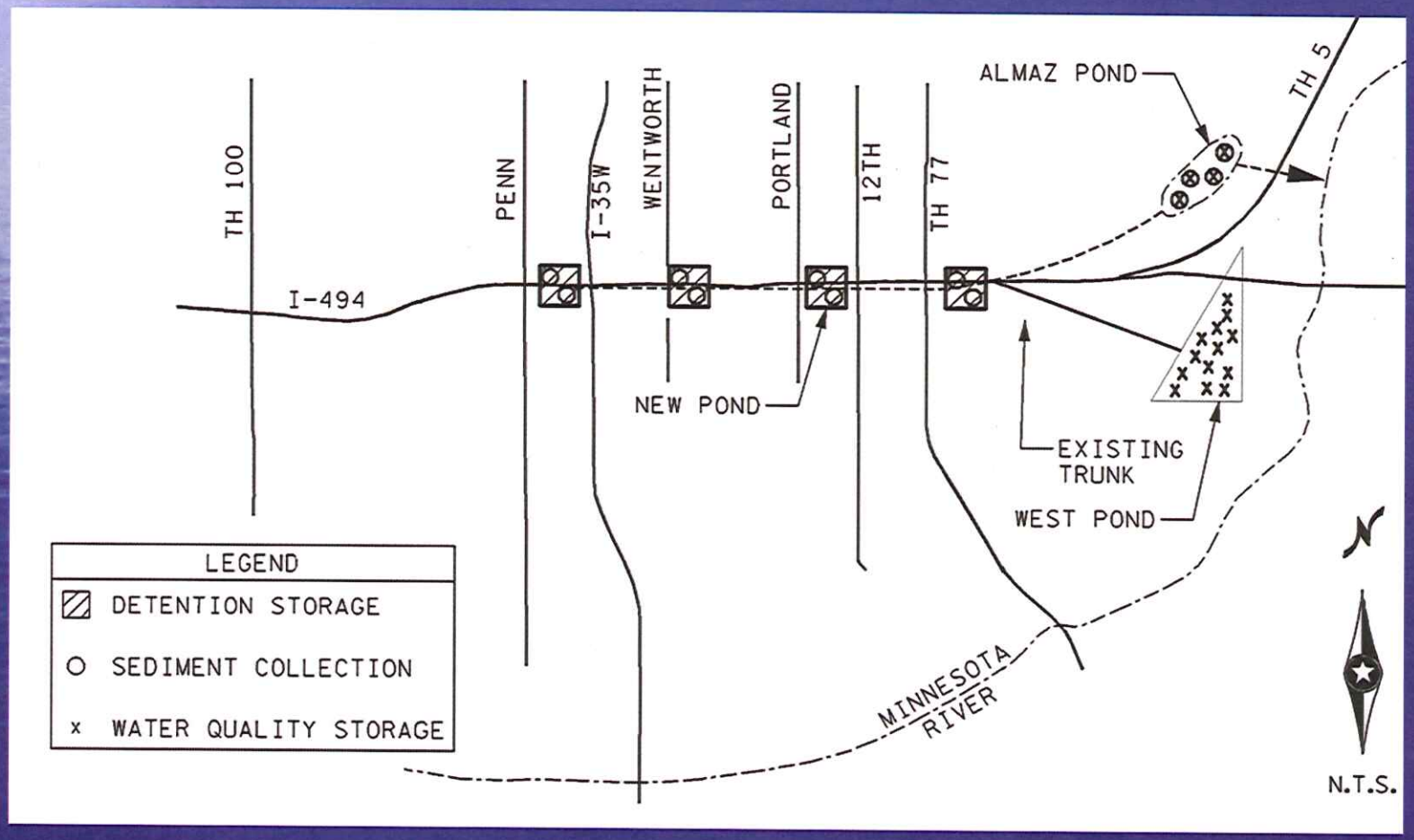


Alternative 2C

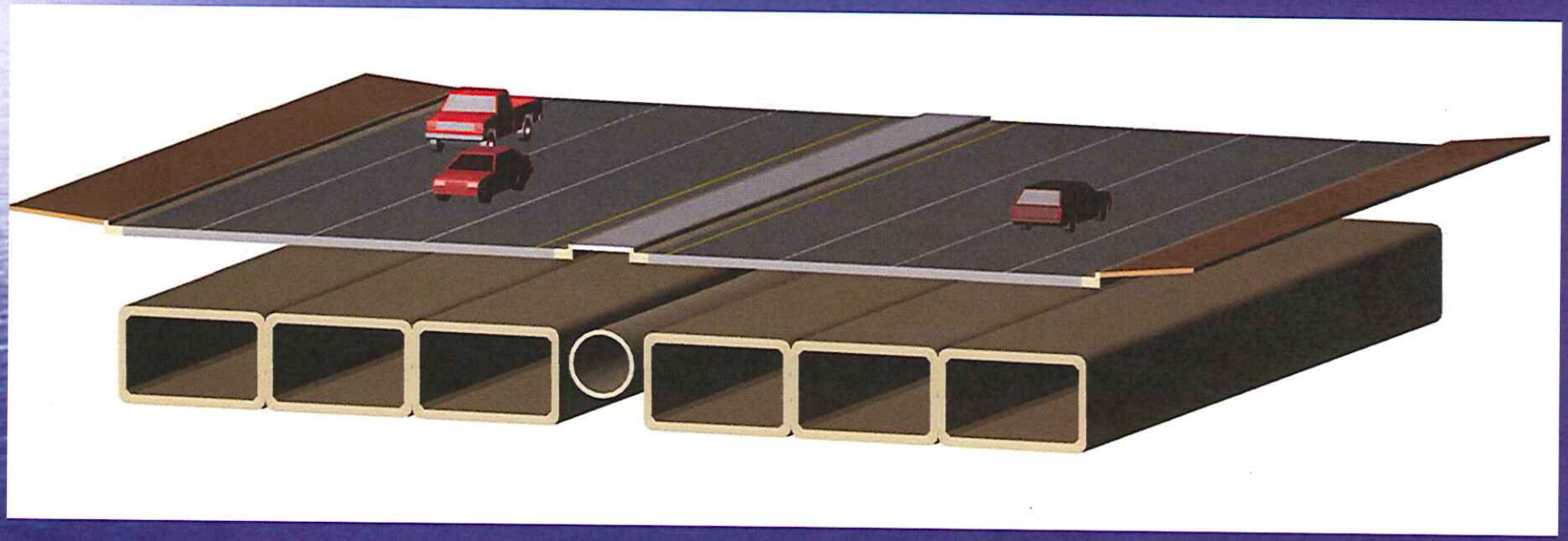
- Construction Cost $ 26.3M
- Property Costs $126.5M
- Maintenance Costs $ 0.5M
- Reconstruction (YR40) $ 7.9M

- Life Cycle Cost (80YR) $161.3M

Alternative 2D – Reuse Existing Storm Sewer System with Buried Ponding



Under Roadway Storage Alternative



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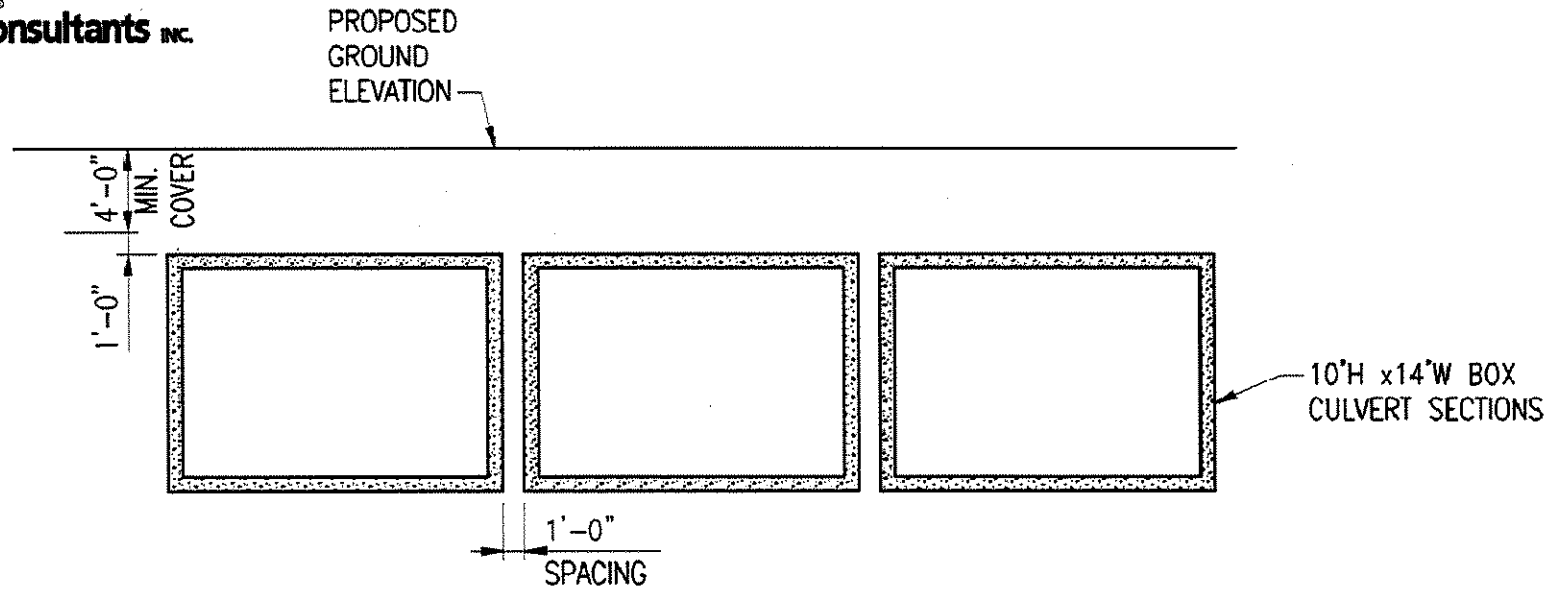

LOCATION	PROPOSED GROUND ELEVATION	GROUNDWATER TABLE	EXISTING SYSTEM INVERT	BOUNCE (ft)
PENN AVE.	826.10	811.2	811.8	3.6
WENTWORTH AVE.	826.60	811.1	811.5	6.2
PORTLAND AVE.	825.30	809.8	805.1	1.3
TH 77	826.90	804.2	799.0	1.7

PRELIMINARY ISSUE
FOR REVIEW
NOT FOR CONSTRUCTION

FIGURE 01
BURIED STORAGE (CULVERT)
I-494 STORMWATER ALTERNATIVES STUDY

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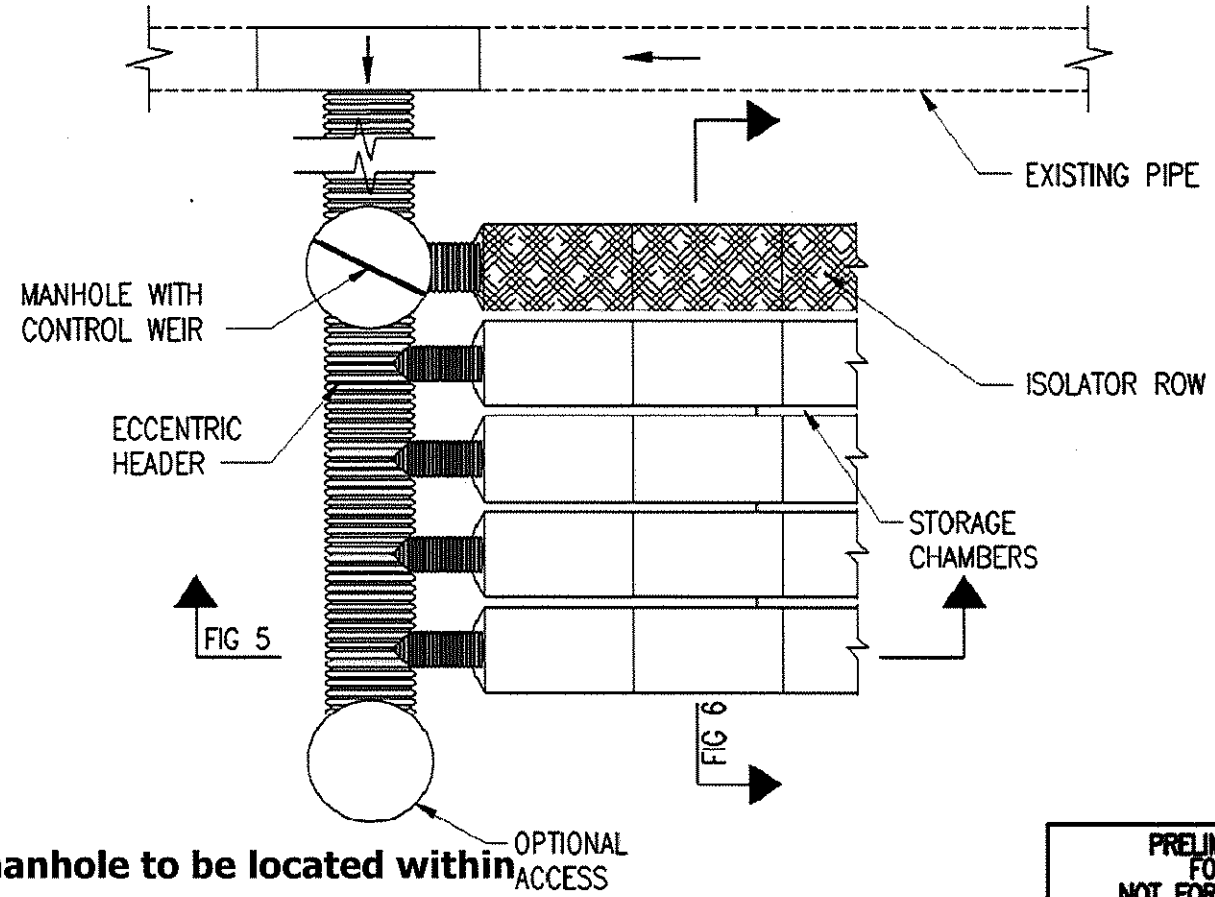

Note:

1. Access and manhole to be located within shoulder or clear zone.

2. Chamber length varies 500-1500' (+/-).

SOURCE: STORMTECH

PRELIMINARY ISSUE
FOR REVIEW
NOT FOR CONSTRUCTION

FIGURE 04
BURIED STORAGE (HDPE) PLAN
I-494 STORMWATER ALTERNATIVES STUDY

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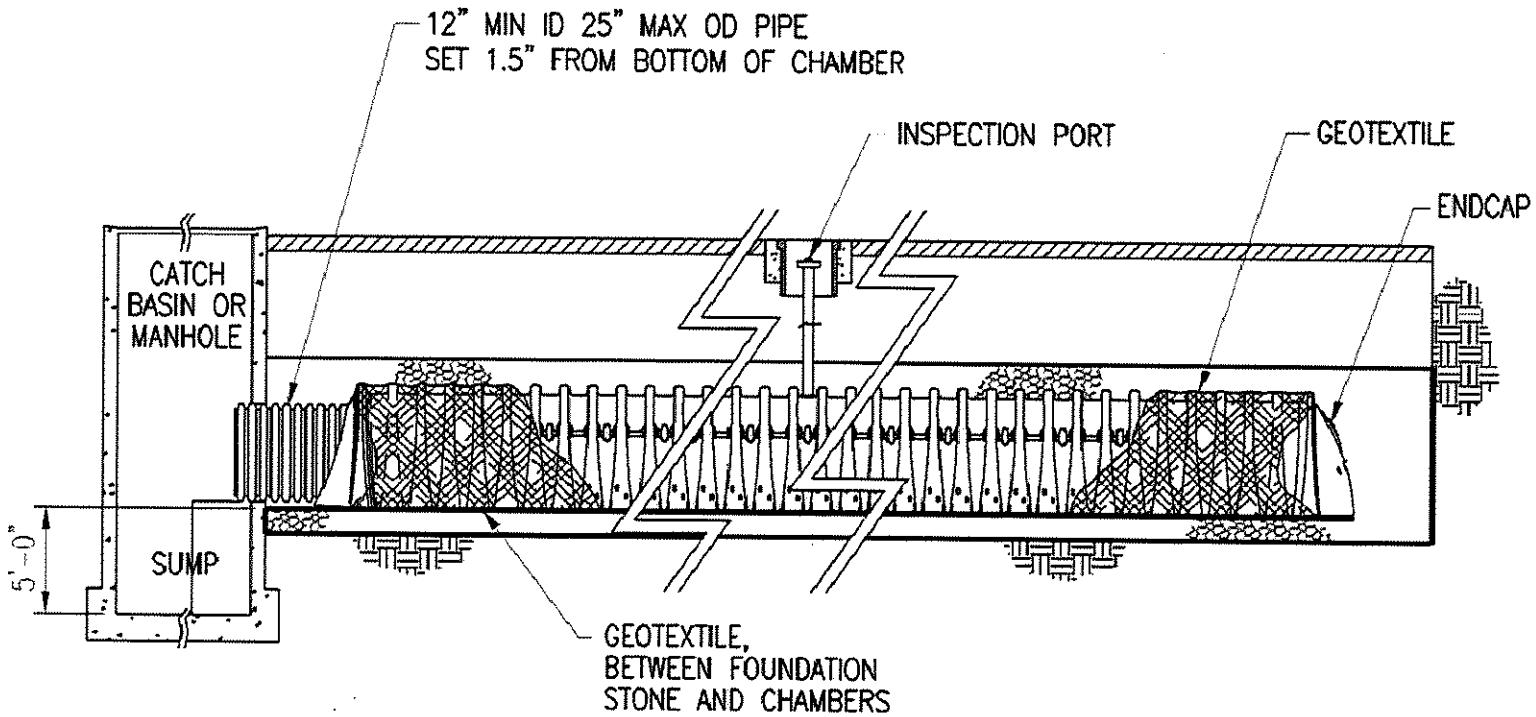

SOURCE: STORMTECH

FIGURE 05
BURIED STORAGE (HDPE) SECTION
I-494 STORMWATER ALTERNATIVES STUDY

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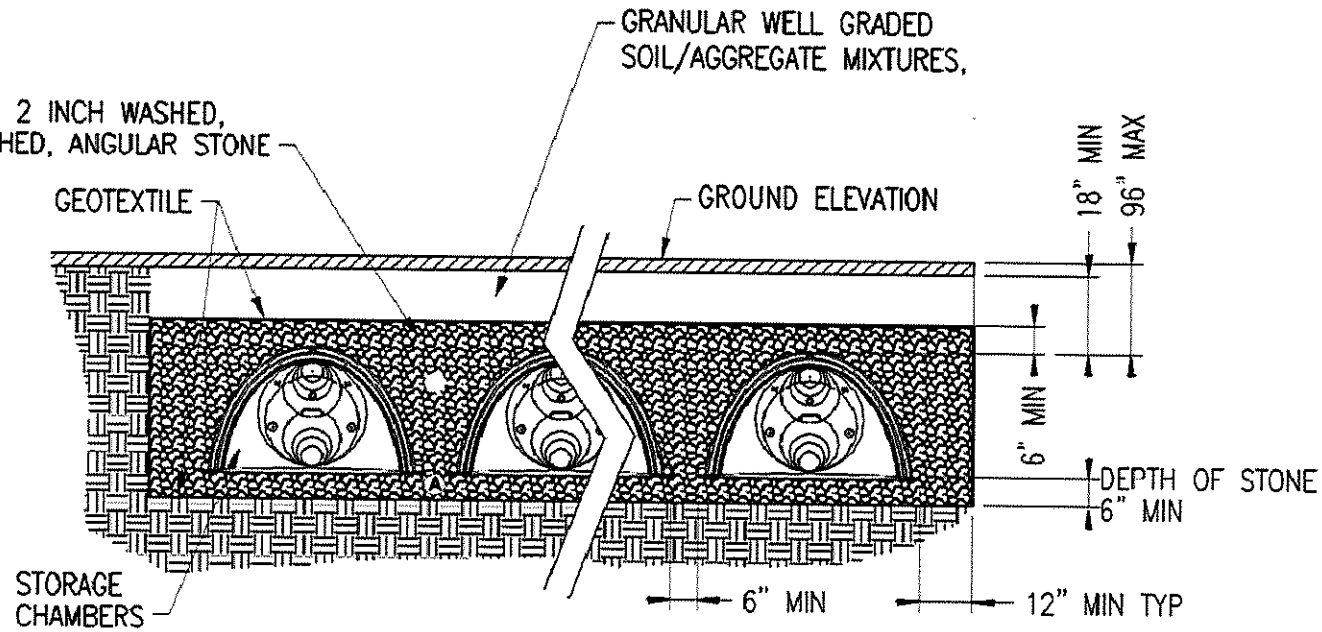
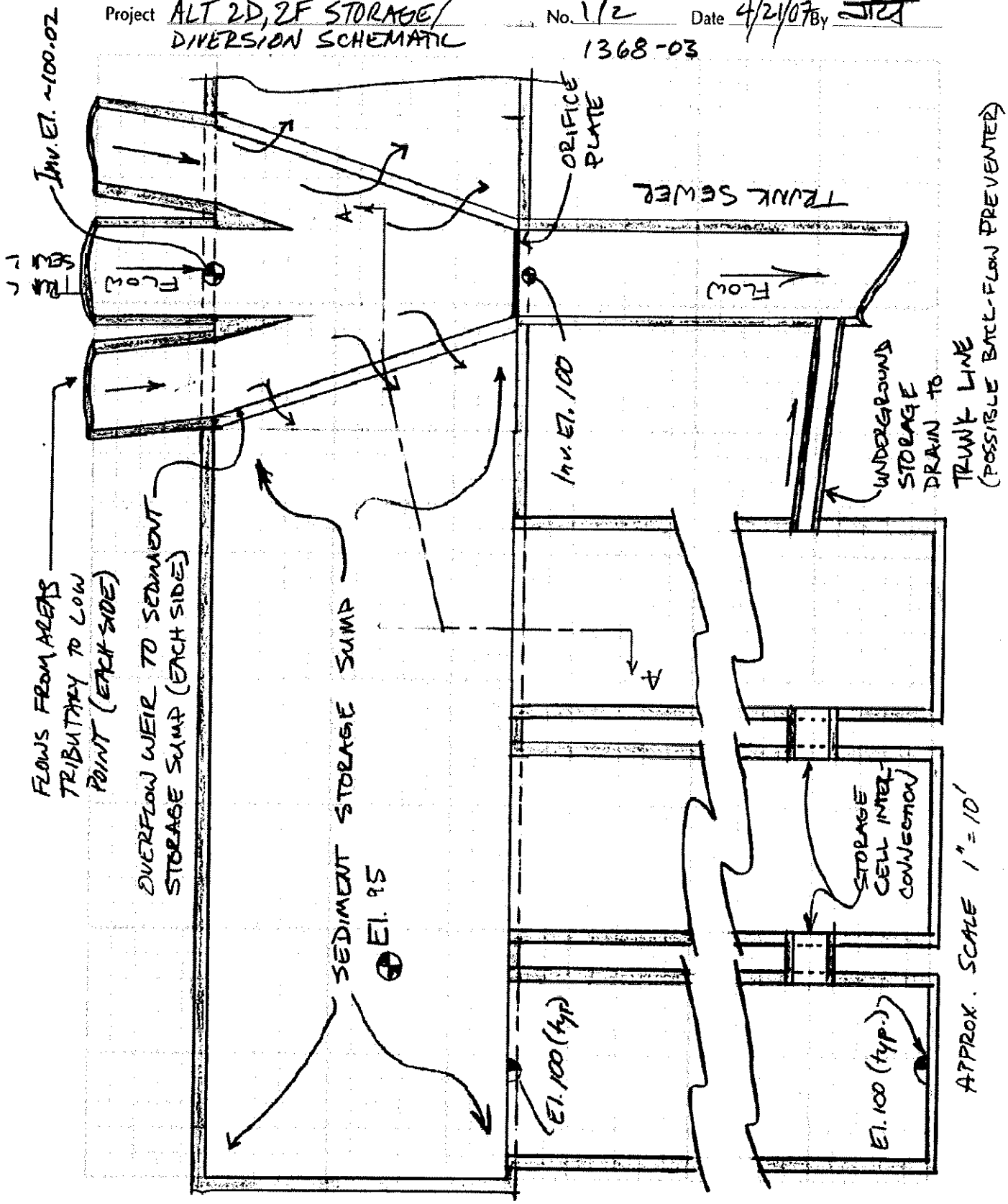


LOCATION	GROUND ELEVATION	GROUNDWATER TABLE	EXISTING SYSTEM INVERT	BOUNCE (ft)
PENN AVE.	830	811.2	811.8	3.6
WENTWORTH AVE.	840	811.1	811.5	6.2
PORTLAND AVE.	830	809.8	805.1	1.3
TH 77	825	804.2	799.0	1.7

PRELIMINARY ISSUE
FOR REVIEW
NOT FOR CONSTRUCTION

FIGURE 06
BURIED STORAGE (HDPE) SECTION
I-494 STORMWATER ALTERNATIVES STUDY

Project ALT 2D, 2F STORAGE/ DIVERSION SCHEMATIC No. 1/2 Date 4/21/07 By
1368-03

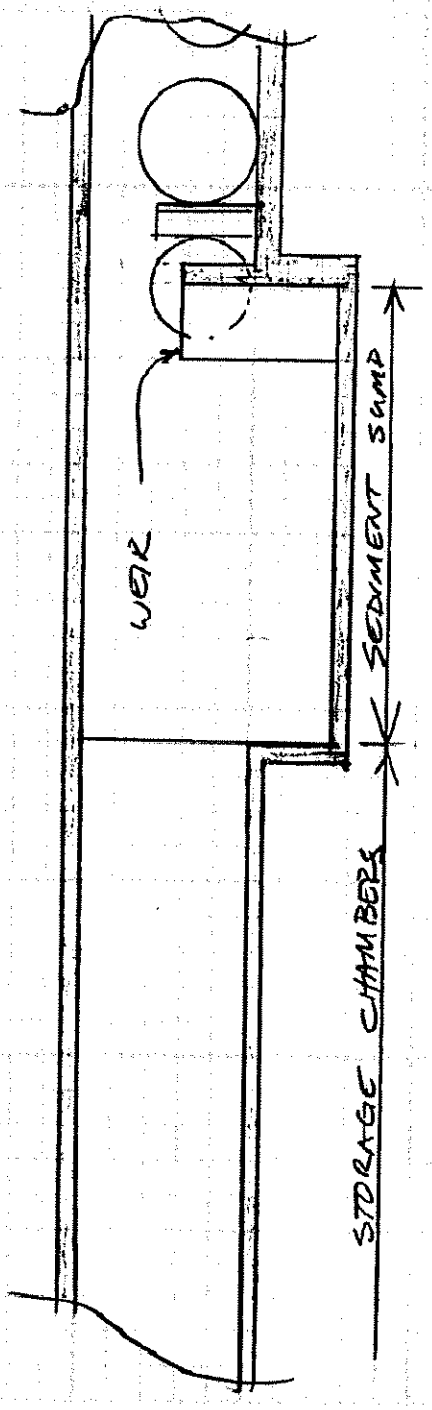


Wenck

Wenck Associates, Inc.
(763) 479-4200
Fax (763) 479-4242

1800 Pioneer Creek Center
P.O. Box 249
Maple Plain, MN 55359-0249

Project _____ No. 2/2 Date 4/21/07 By [illegible]



SECTION A-A

APPROX. SCALE 1" = 10'

Wenck

Wenck Associates, Inc.
(763) 479-4200
Fax (763) 479-4242

1800 Pioneer Creek Center
P.O. Box 249
Maple Plain, MN 55359-0249

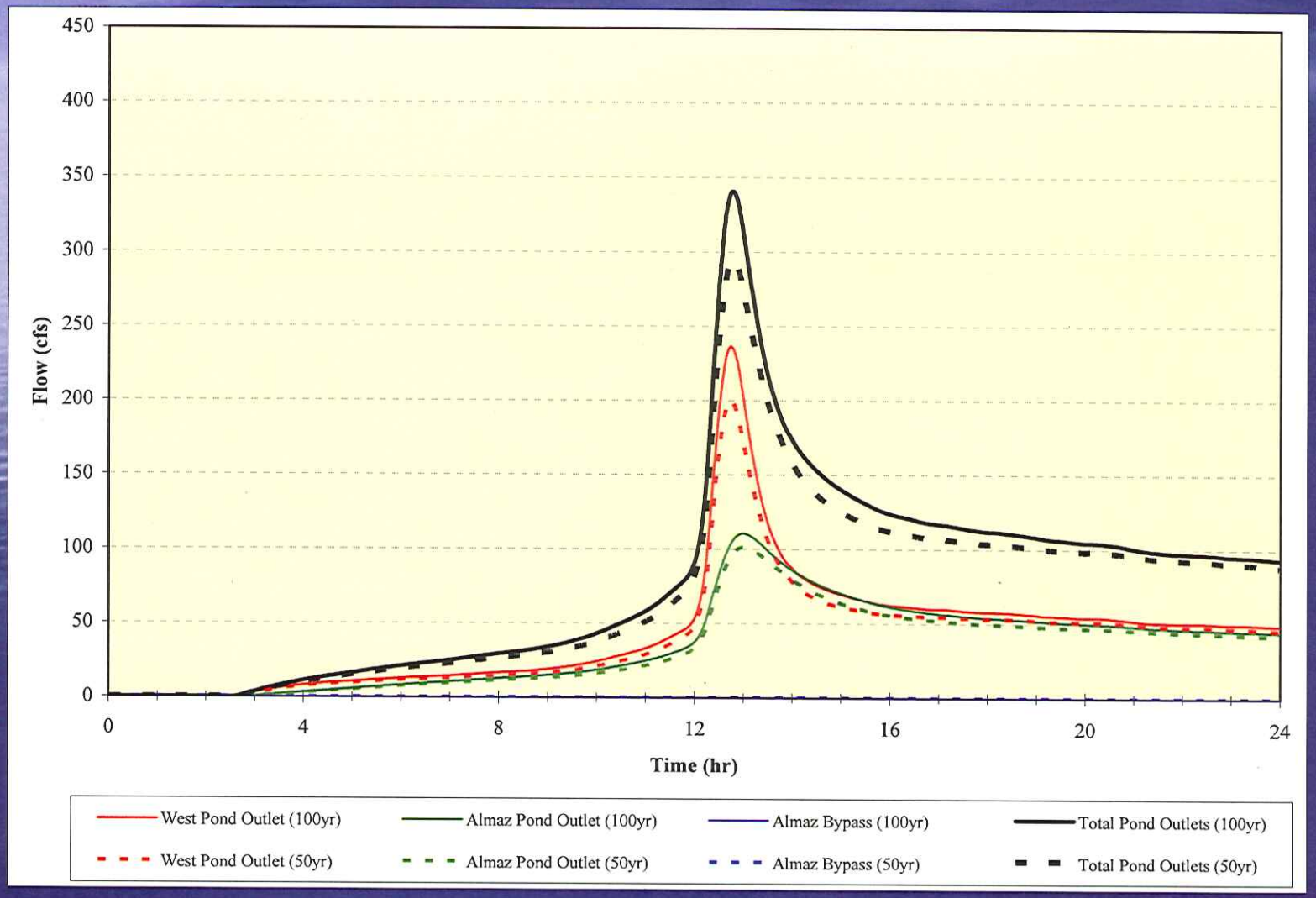
Alternative 2D

- Outfall: Almaz, West Pond
- Underground ponds at Penn, Wentworth, Portland and TH 77
- Penn – volume for 100-year runoff; pumped over 24 hours to Colfax (4,000 ft)
- Wentworth – off-line
- Portland – off-line
- TH 77 – off-line
- No phosphorus removal in underground ponds

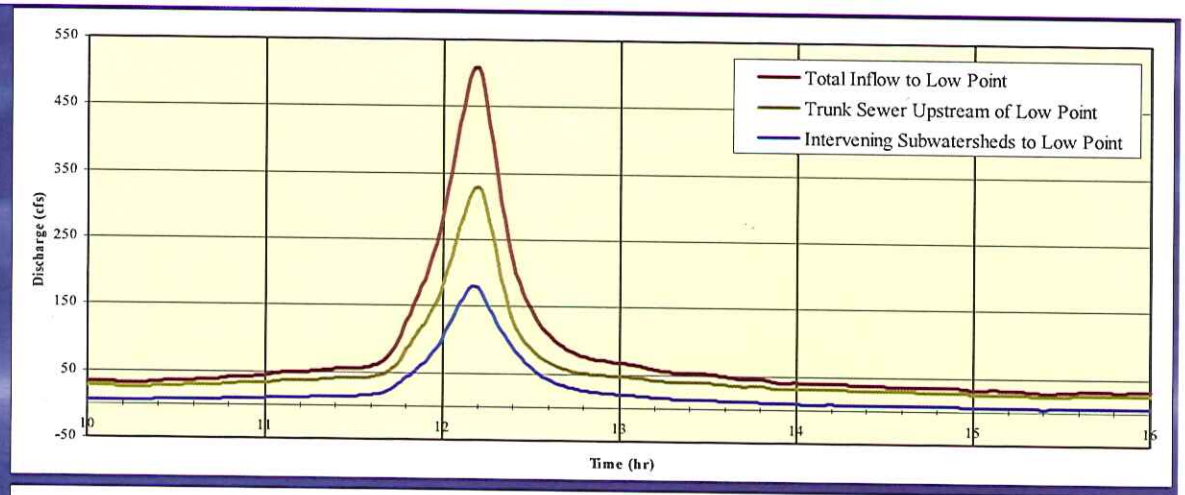
Alternative 2D WQ, Sediment

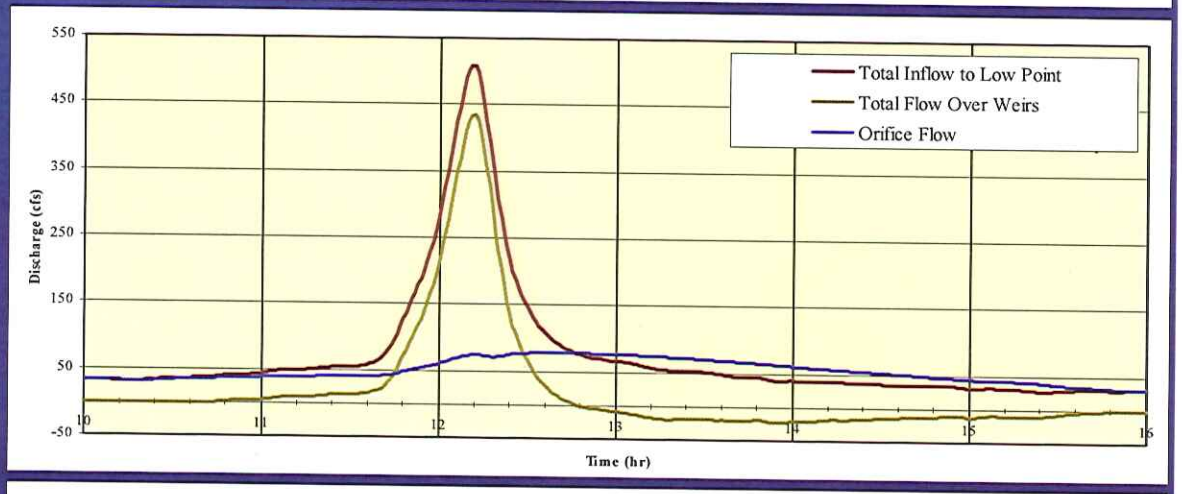
- WQ – Flow split with West Pond: 33 ac-ft
- Underground pond inlets designed to maximize sediment bypass
- Approximately 15 percent of suspended sediment delivered to sumps in underground ponds
- Remaining suspended sediment and bed load delivered to Almaz and West Ponds

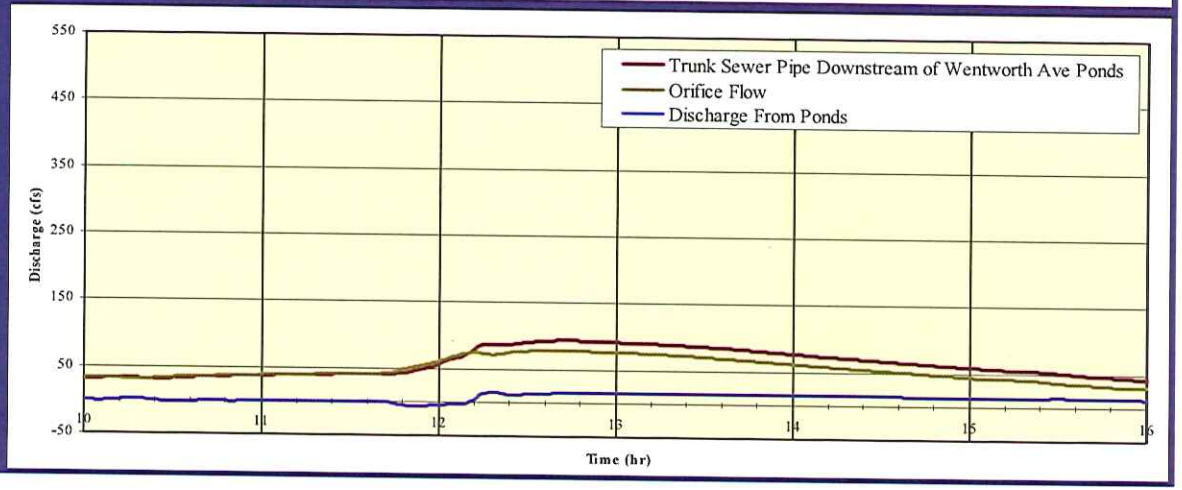
Alternative 2D



Alt. 2D – Wentworth Pond Operations





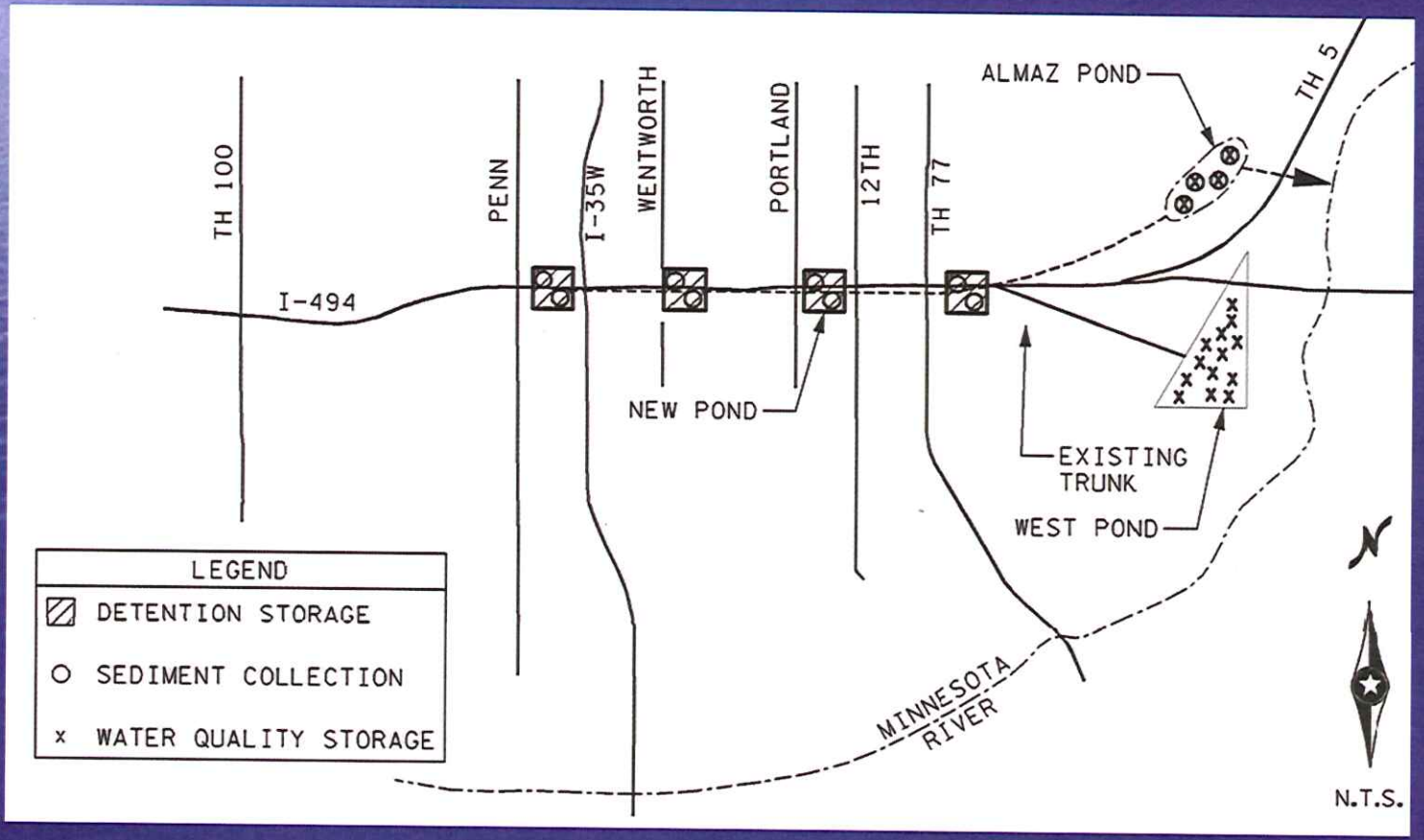


Alternative 2D

- Construction Cost $130.1M
- Property Costs $ 0.0M
- Maintenance Costs $ 0.5M
- Reconstruction (YR40) $ 36.3M

- Life Cycle Cost (80YR) $166.9M

Alternative 2E – Reuse Existing Sewer with Adjacent and Buried Ponding



Alternative 2E

- Hydraulics are similar to 2D

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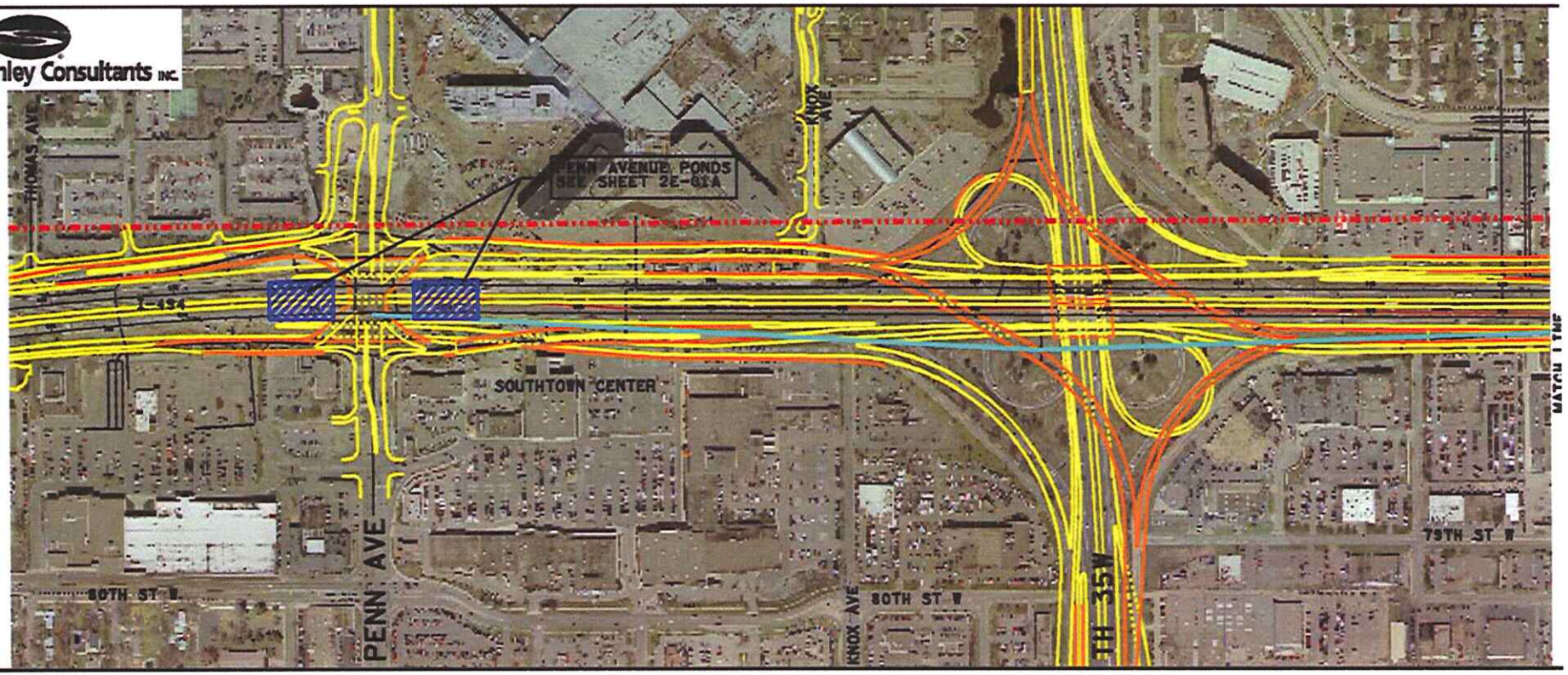

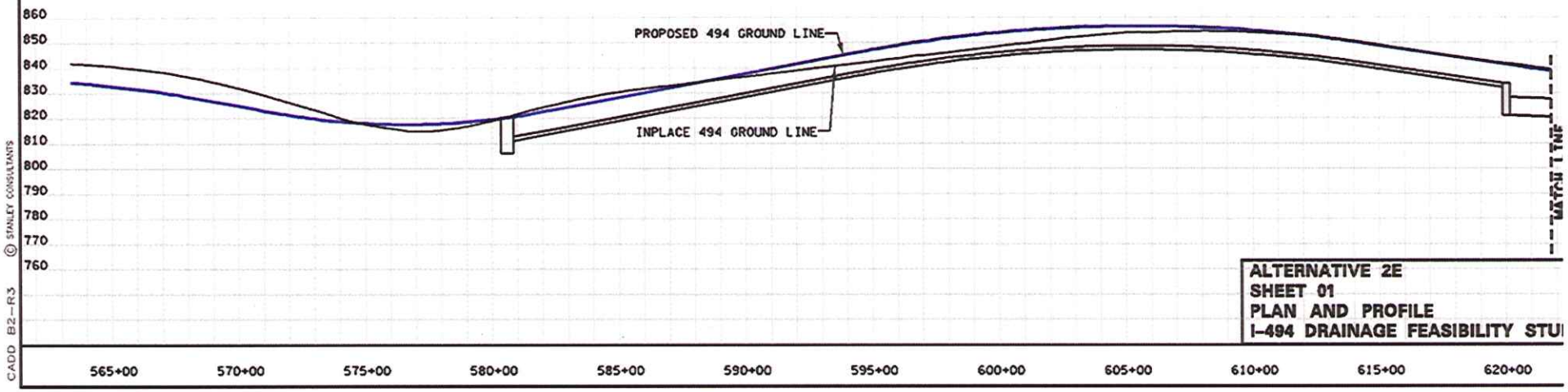

ALTERNATIVE 2E
SHEET 01
PLAN AND PROFILE
I-494 DRAINAGE FEASIBILITY STU

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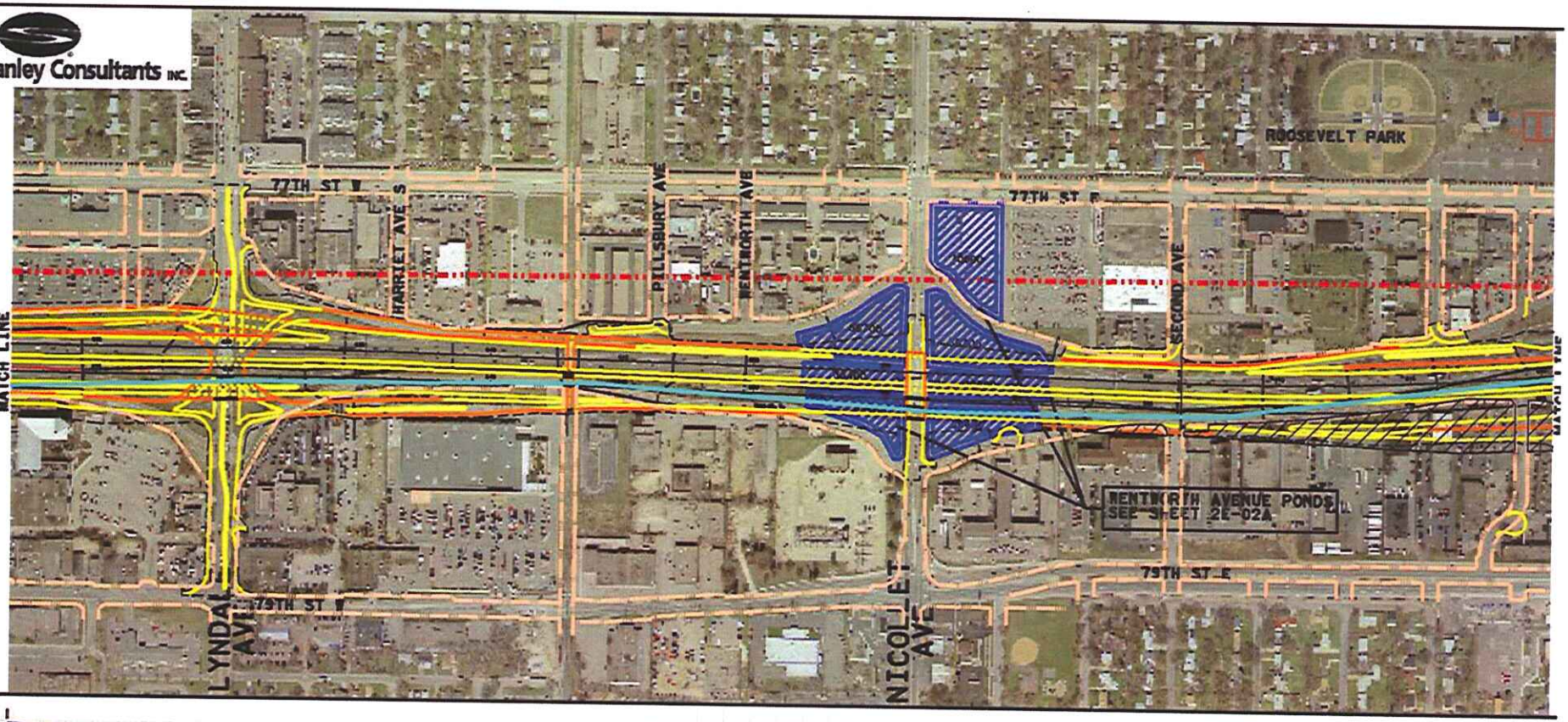

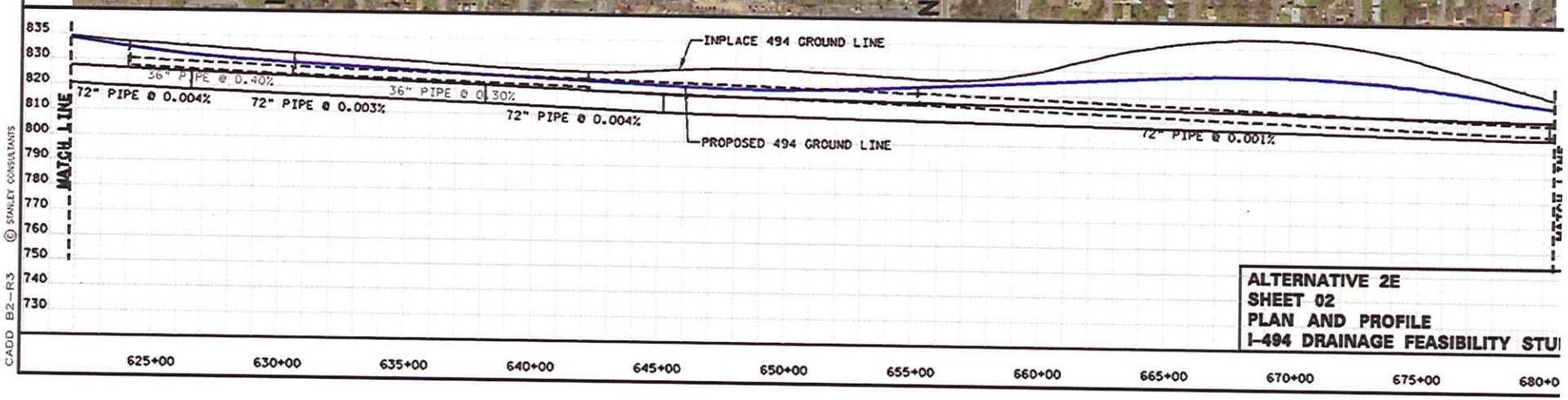

ALTERNATIVE 2E
SHEET 02
PLAN AND PROFILE
I-494 DRAINAGE FEASIBILITY STU

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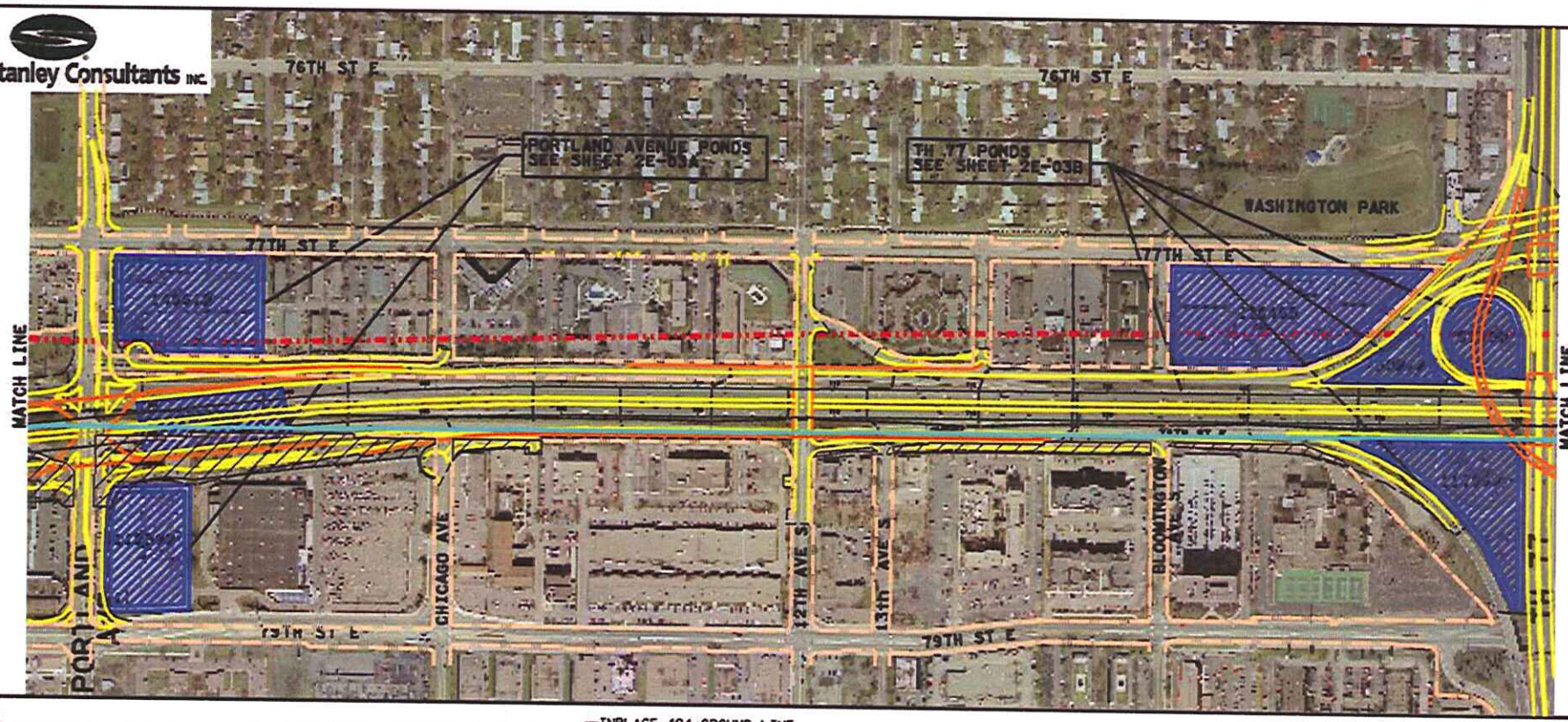

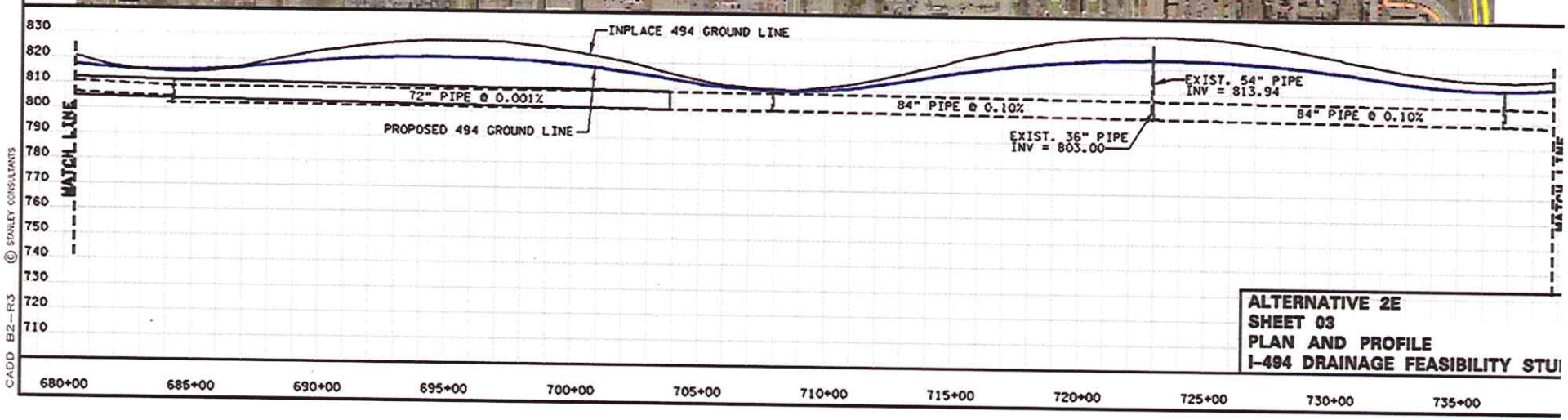

ALTERNATIVE 2E
SHEET 03
PLAN AND PROFILE
I-494 DRAINAGE FEASIBILITY STU

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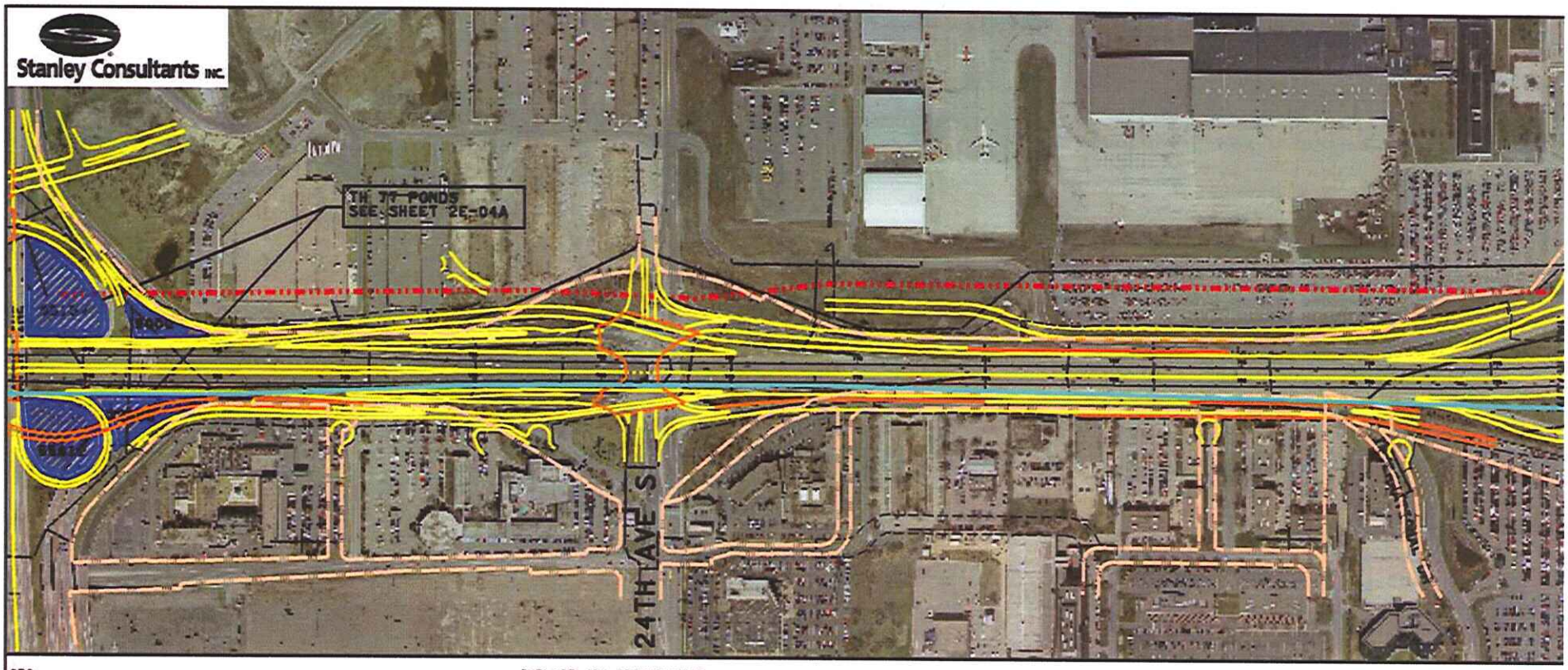

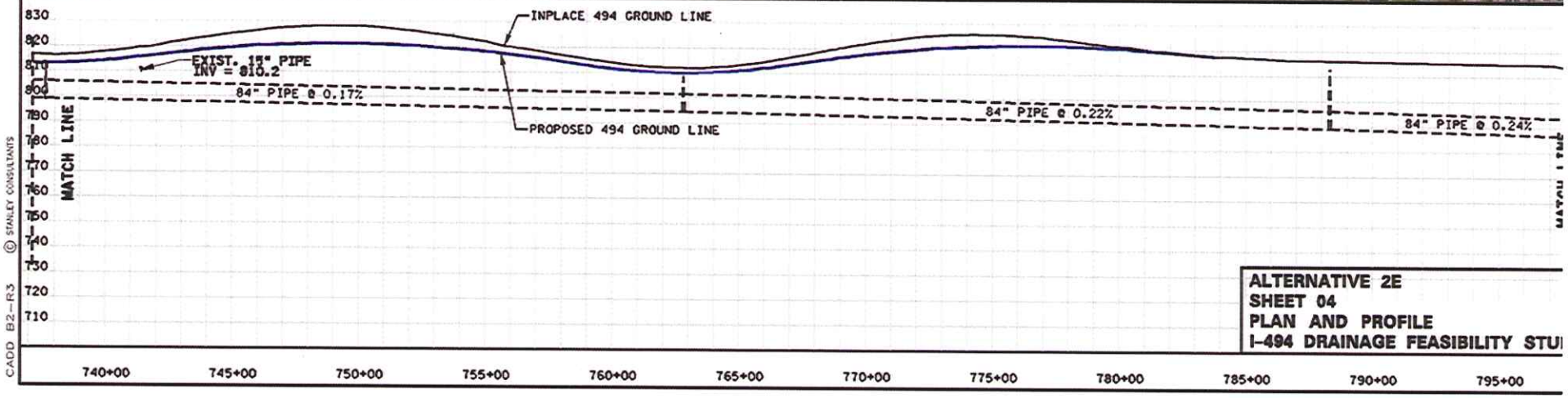

ALTERNATIVE 2E
SHEET 04
PLAN AND PROFILE
I-494 DRAINAGE FEASIBILITY STU

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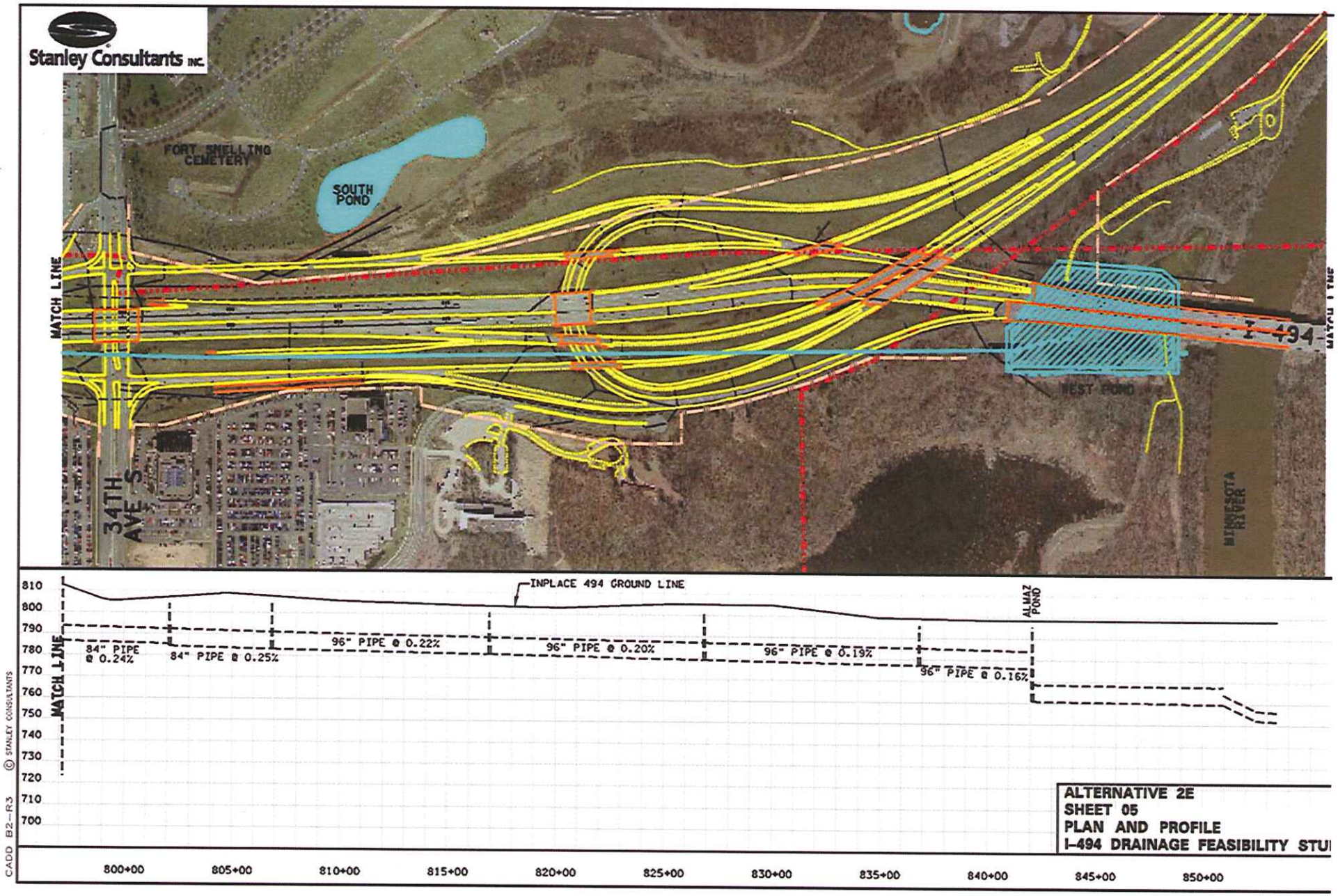

ALTERNATIVE 2E
SHEET 05
PLAN AND PROFILE
I-494 DRAINAGE FEASIBILITY STU

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Alternative 2E

- Construction Cost $ 59.1M
- Property Costs $ 35.7M
- Maintenance Costs $ 0.5M
- Reconstruction (YR40) $ 19.7M

- Life Cycle Cost (80YR) $114.9M

Alternative 2F – Reuse Existing Sewer with Buried Ponding and Sealed System (or Lowered Groundwater)

- Same as 2D, but with minimum water level five feet lower at Portland and TH 77 ponds
- Pond area reduced from 24.4 to 8.4 acres

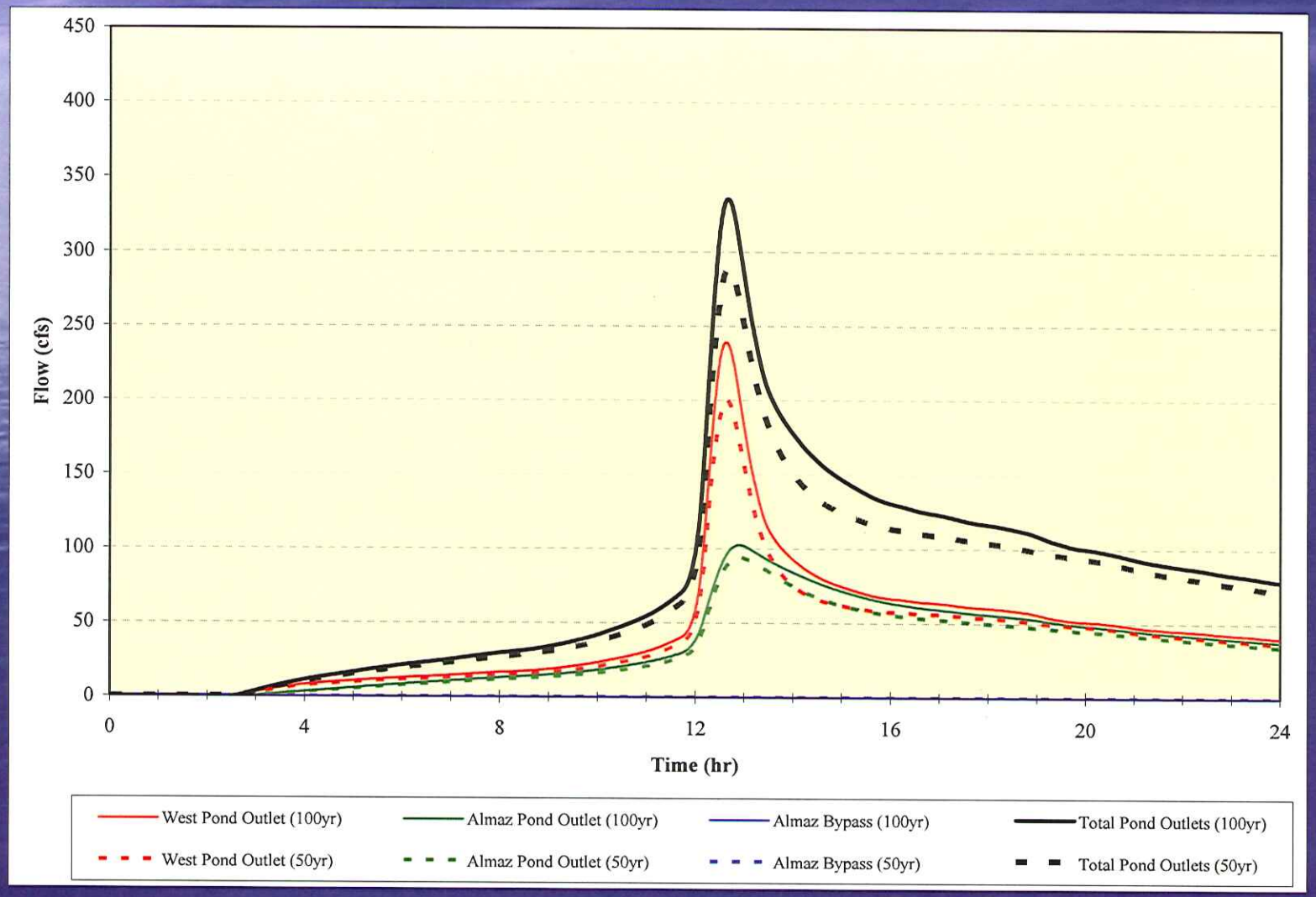
Alternative 2F

- Outfall: Almaz, West Pond
- Underground ponds at Penn, Wentworth, Portland and TH 77
- Penn – volume for 100-year runoff; pumped over 24 hours to Colfax (4,000 ft)
- Wentworth – off-line
- Portland – off-line
- TH 77 – off-line
- No phosphorus removal in underground ponds

Alternative 2F WQ, Sediment

- WQ – Flow split with West Pond: 33 ac-ft
- Underground pond inlets designed to maximize sediment bypass
- Approximately 15 percent of suspended sediment delivered to sumps in underground ponds
- Remaining suspended sediment and bed load delivered to Almaz and West Ponds

Alternative 2F

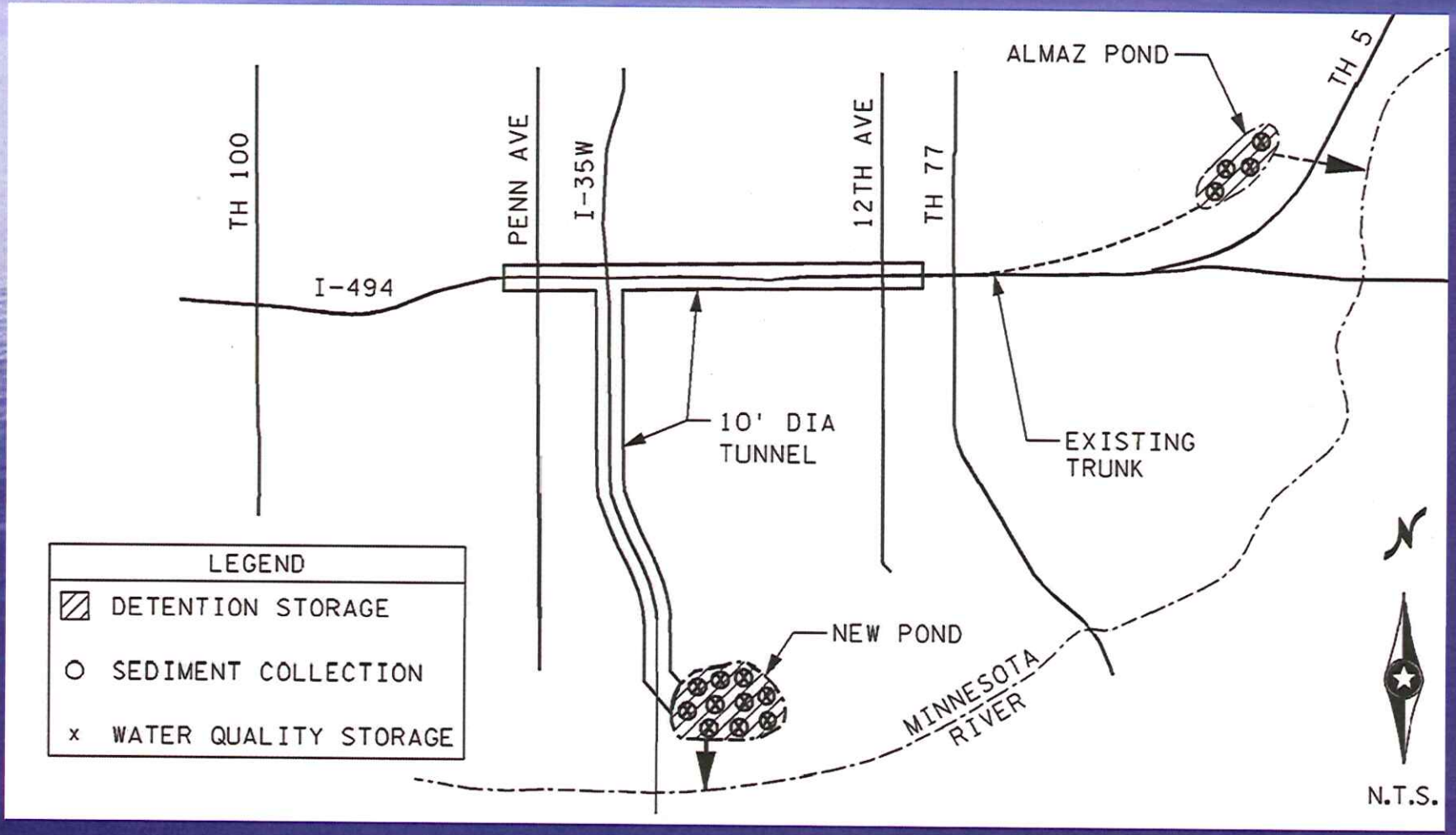


Alternative 2F

- Construction Cost $ 49.1M
- Property Costs $ 0.0M
- Maintenance Costs $ 0.5M
- Reconstruction (YR40) $ 14.5M

- Life Cycle Cost (80YR) $ 64.2M

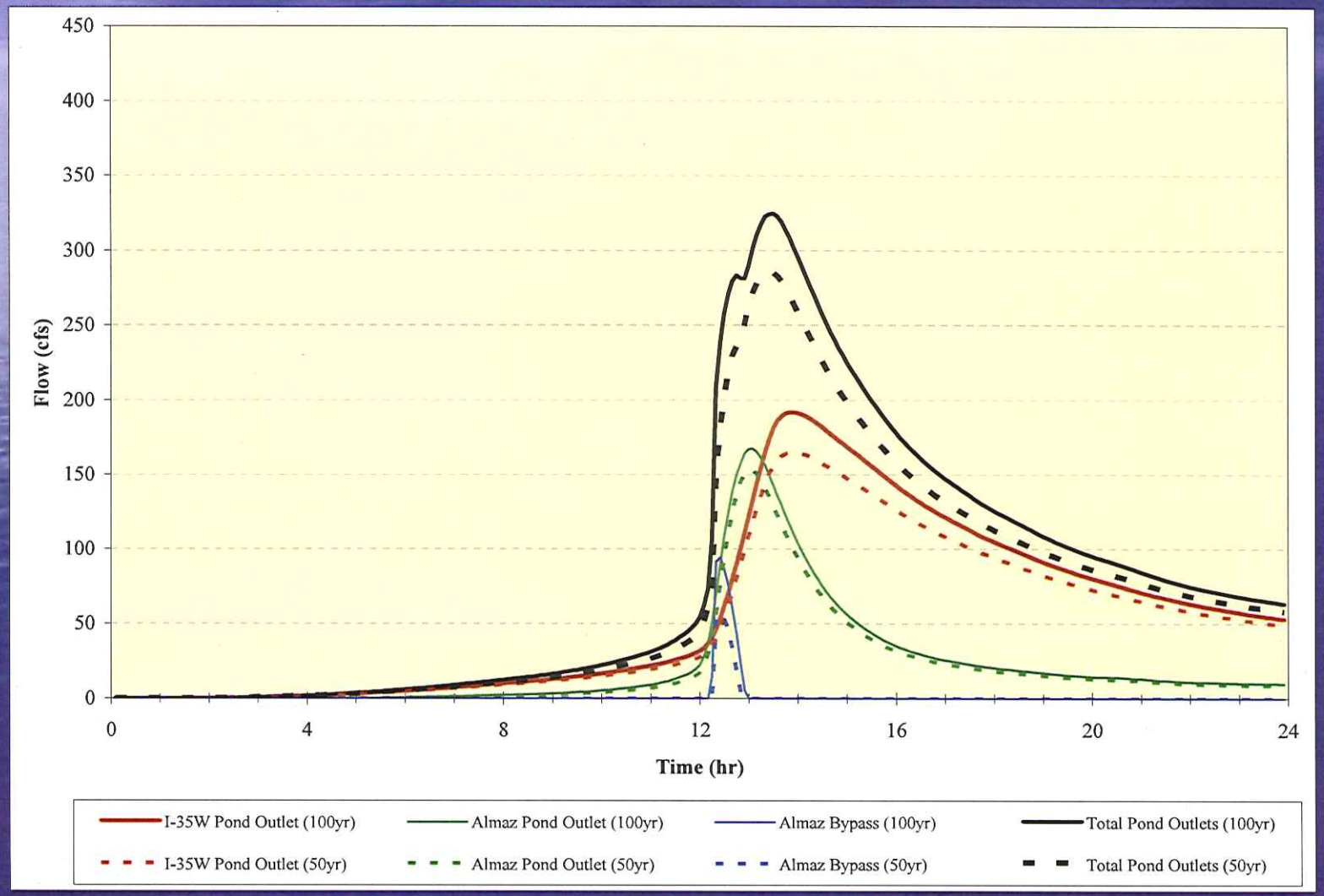
Alternative 4A – Conveyance Tunnel along I-35W



Alternative 4A

- Outfall: Almaz, Almaz Bypass, I-35W Pond
- 10-ft Tunnel, Penn to I-35W, TH 77 to I-35W, then along I-35W to Minnesota River
- Earth-pressure-balanced construction
- Segmental concrete-lined, water-tight
- Vortex drop shafts at Penn, Wentworth, Portland and TH 77
- Rate control pond: 9.2 ac with 5.5 ft bounce (Might be excluded)
- WQ: 38 ac-ft at I-35W Pond; 6.2 ac
- Sediment accumulation in ponds

Alternative 4A

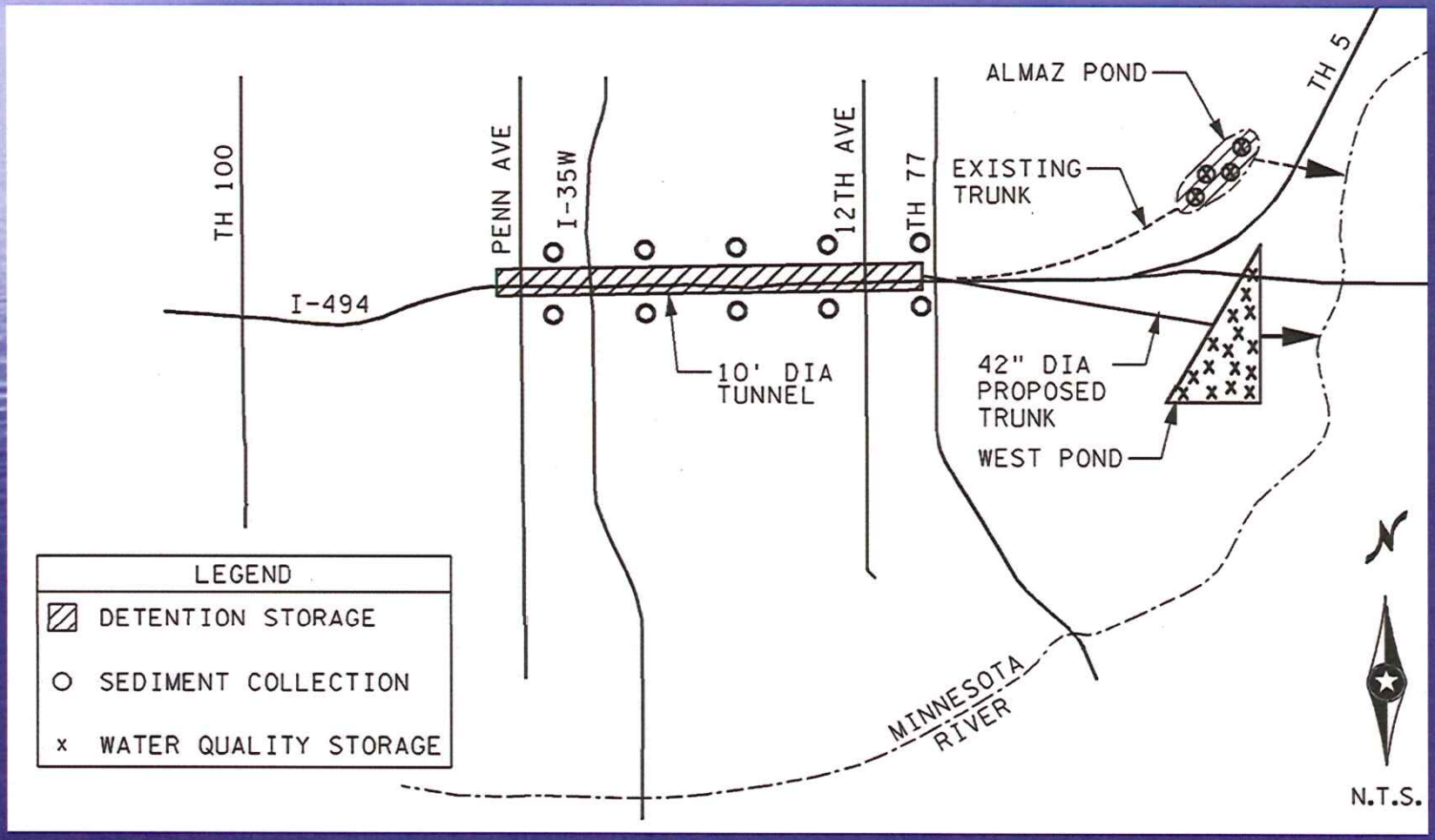


Alternative 4A

- Construction Cost $169.6M
- Property Costs $ 0.9M
- Maintenance Costs $ 0.4M
- Reconstruction (YR40) $ 1.7M

- Life Cycle Cost (80YR) $172.7M

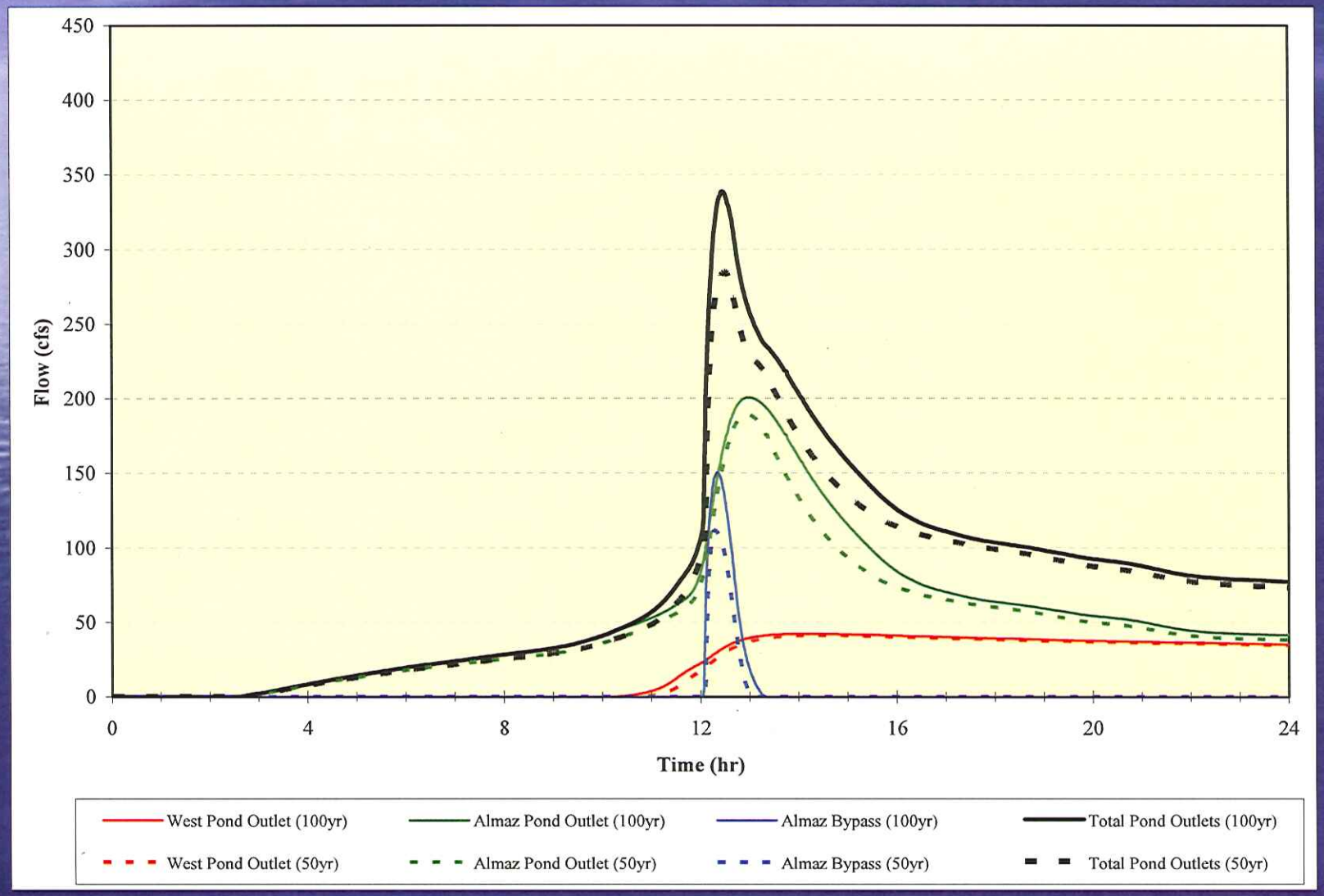
Alternative 5A – Storage Tunnel with Gravity Outfall

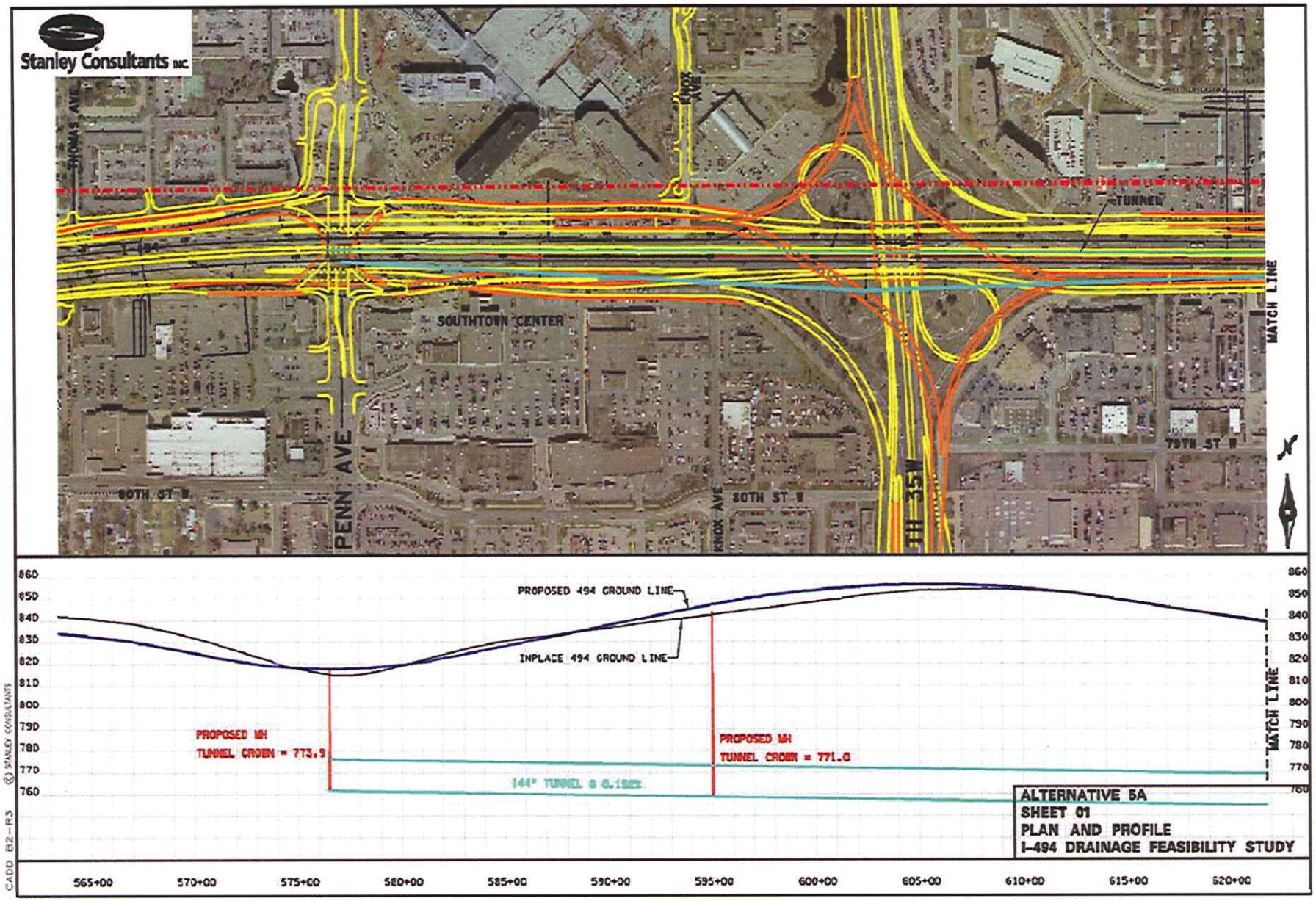


Alternative 5A

- Outfall: Almaz, Almaz Bypass, West Pond
- 3-mile, 12-ft Tunnel, Wentworth to TH 77
- Earth-pressure-balanced construction
- Segmental concrete-lined, water-tight
- Vortex drop shafts at Penn, Wentworth, Portland and TH 77
- Rate control provided by 42" microtunnel from TH 77 downstream
- WQ: 33 ac-ft at West Pond over 6.2 acres
- Sediment accumulation in ponds

Alternative 5A




Stanley Consultants INC.
THOMAS AVE
494
PENN AVE
SOUTHTOWN CENTER
80TH ST W
KNOX AVE
80TH ST W
35W
TUNNEL
79TH ST W
MATCH LINE
PROPOSED 494 GROUND LINE
INPLACE 494 GROUND LINE
PROPOSED MH
TUNNEL CROWN = 773.9
PROPOSED MH
TUNNEL CROWN = 771.0
144" TUNNEL @ 0.1822%
MATCH LINE
860
850
840
830
820
810
800
790
780
770
760
565+00
570+00
575+00
580+00
585+00
590+00
595+00
600+00
605+00
610+00
615+00
620+00
ALTERNATIVE 5A
SHEET 01
PLAN AND PROFILE
I-494 DRAINAGE FEASIBILITY STUDY
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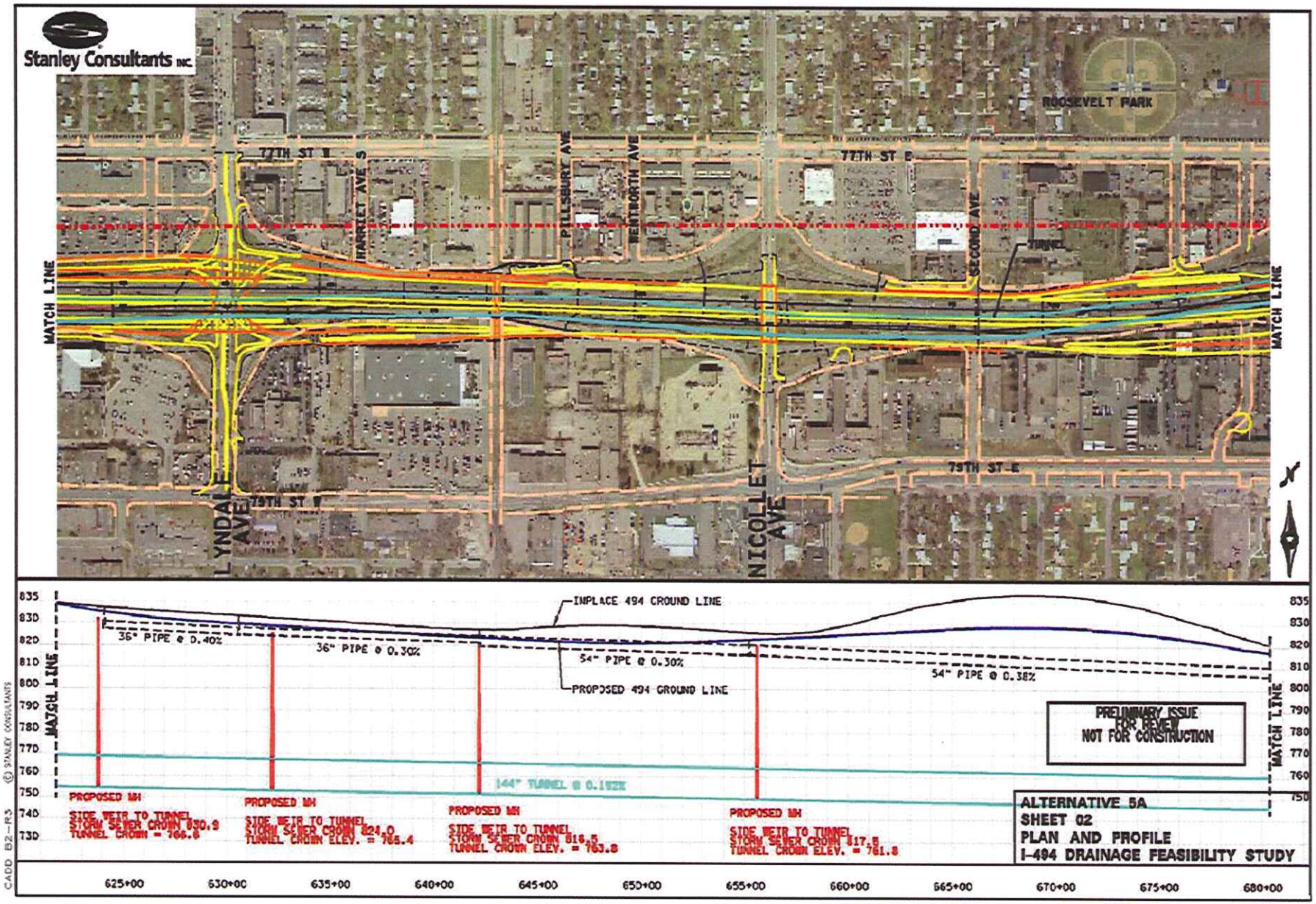
Stanley Consultants INC.
ROOSEVELT PARK
77TH ST E
77TH ST E
HARRIET AVE S
PILLSBURY AVE
BENTBORTH AVE
SECOND AVE
TUNNEL
MATCH LINE
MATCH LINE
LYNDALE AVE
79TH ST E
NICOLLET AVE
79TH ST E
INPLACE 494 GROUND LINE
36" PIPE @ 0.40%
36" PIPE @ 0.30%
54" PIPE @ 0.30%
PROPOSED 494 GROUND LINE
54" PIPE @ 0.38%
PRELIMINARY ISSUE
FOR REVIEW
NOT FOR CONSTRUCTION
144" TUNNEL @ 0.152%
PROPOSED MH
SIDE WEIR TO TUNNEL
STORM SEWER CROWN 830.9
TUNNEL CROWN = 766.6
PROPOSED MH
SIDE WEIR TO TUNNEL
STORM SEWER CROWN 824.0
TUNNEL CROWN ELEV. = 765.4
PROPOSED MH
SIDE WEIR TO TUNNEL
STORM SEWER CROWN 816.5
TUNNEL CROWN ELEV. = 763.8
PROPOSED MH
SIDE WEIR TO TUNNEL
STORM SEWER CROWN 817.5
TUNNEL CROWN ELEV. = 761.8
ALTERNATIVE 5A
SHEET 02
PLAN AND PROFILE
I-494 DRAINAGE FEASIBILITY STUDY
835
830
820
810
800
790
780
770
760
750
740
730
625+00
630+00
635+00
640+00
645+00
650+00
655+00
660+00
665+00
670+00
675+00
680+00
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CADD B2-R3

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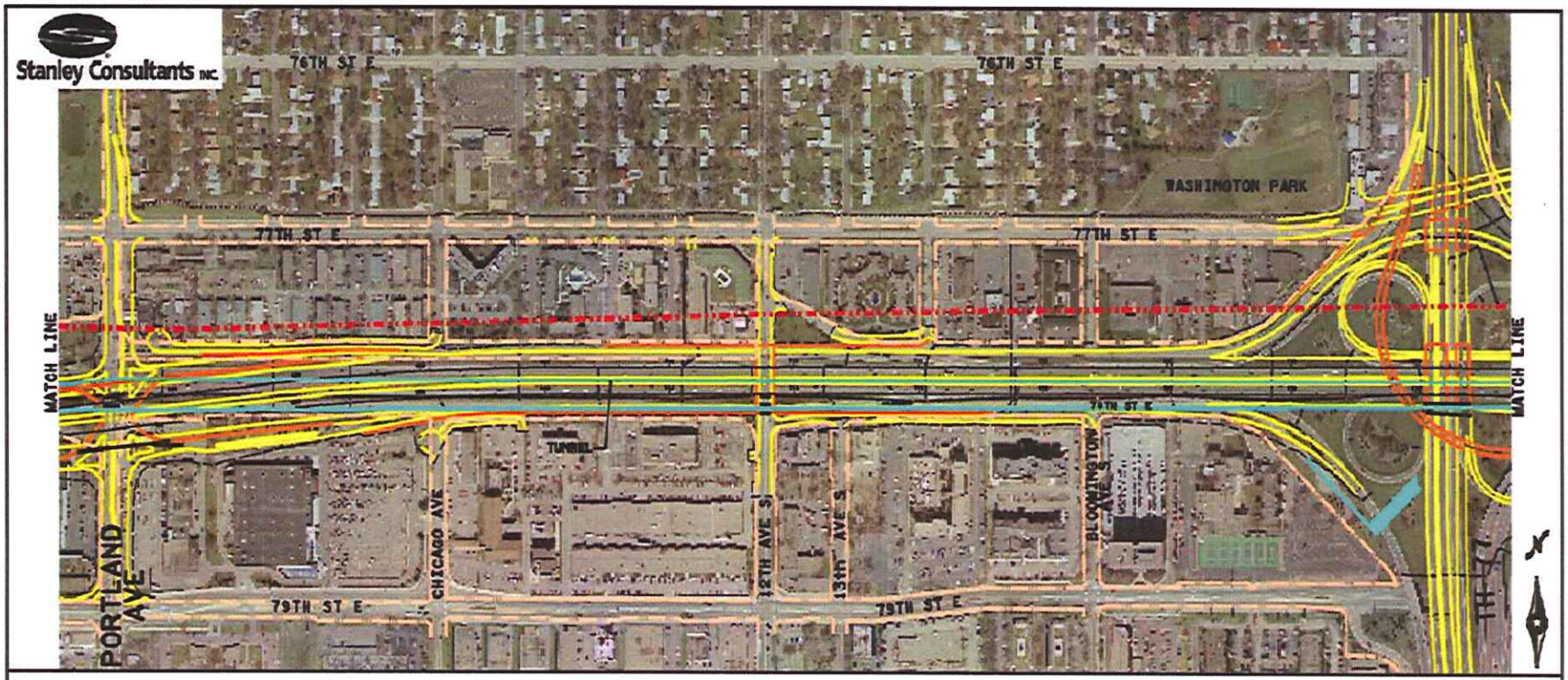

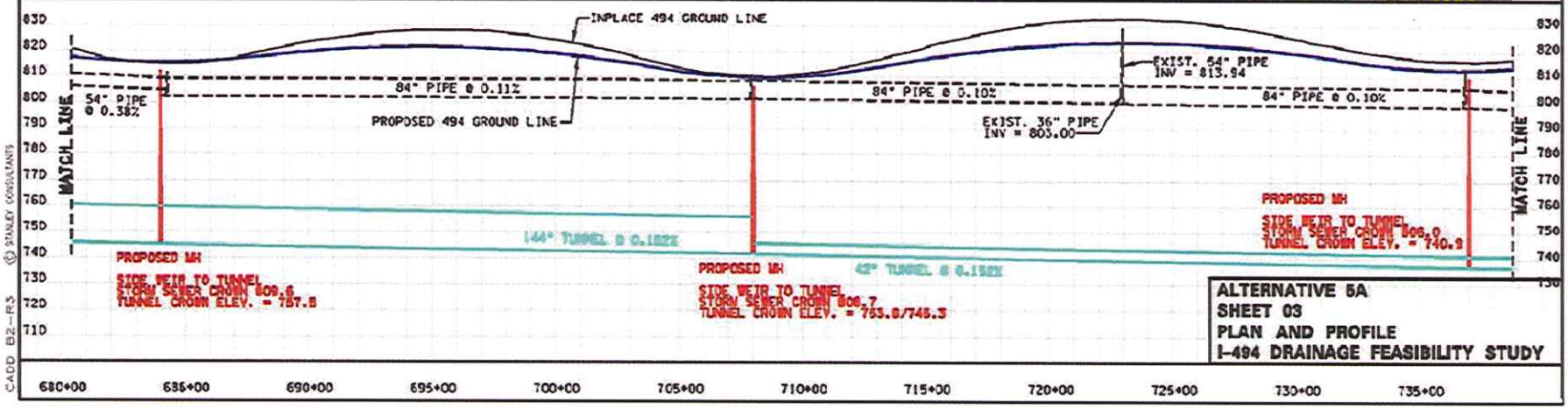

ALTERNATIVE 5A
SHEET 03
PLAN AND PROFILE
I-494 DRAINAGE FEASIBILITY STUDY

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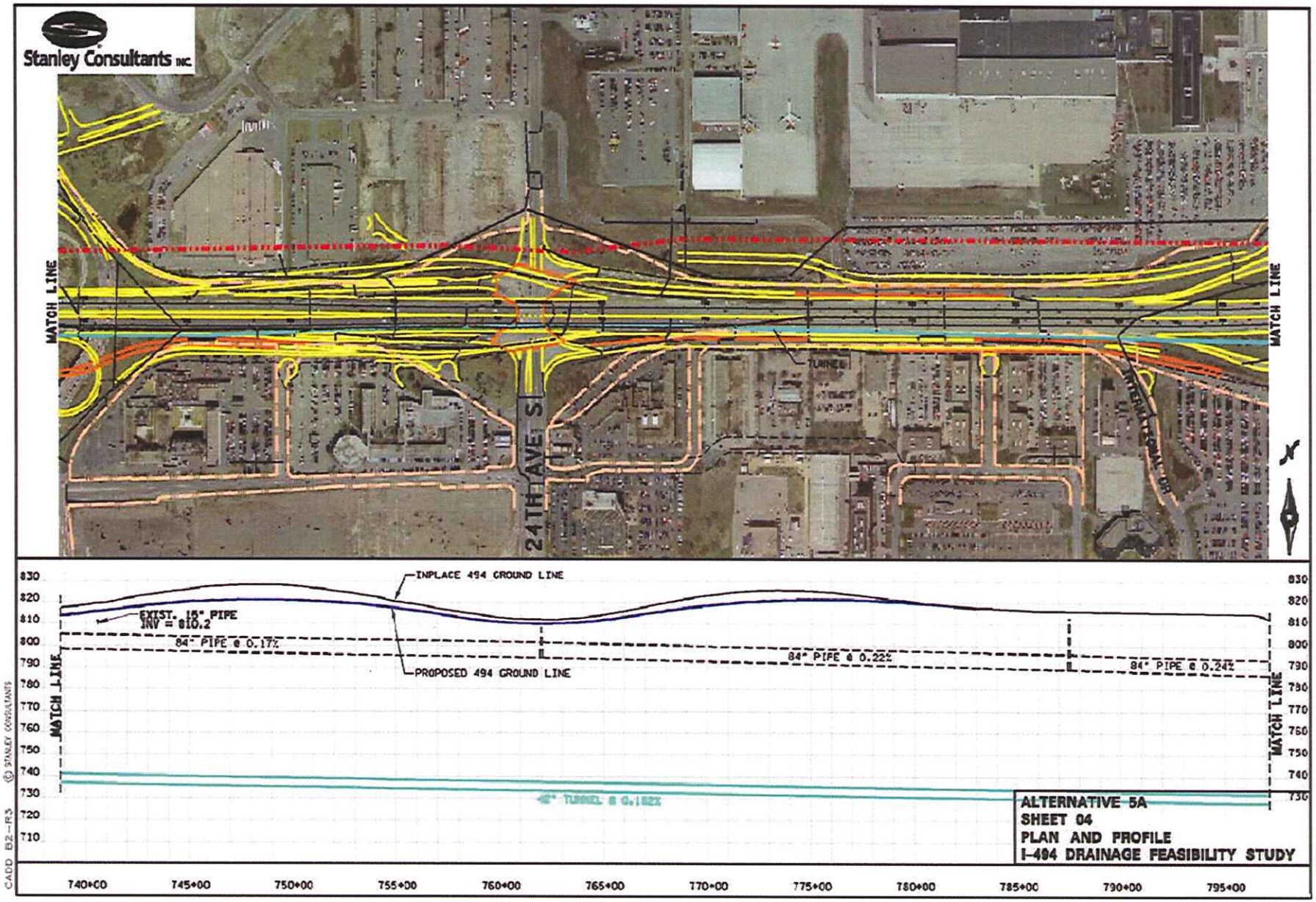
Stanley Consultants INC.
MATCH LINE
24TH AVE S
TUNNEL
MATCH LINE
INPLACE 494 GROUND LINE
EXIST. 15" PIPE
INV = 810.2
84" PIPE @ 0.17%
84" PIPE @ 0.22%
84" PIPE @ 0.24%
PROPOSED 494 GROUND LINE
MATCH LINE
MATCH LINE
48" TUNNEL @ 0.182%
830
820
810
800
790
780
770
760
750
740
730
720
710
740+00
745+00
750+00
755+00
760+00
765+00
770+00
775+00
780+00
785+00
790+00
795+00
ALTERNATIVE 5A
SHEET 04
PLAN AND PROFILE
I-494 DRAINAGE FEASIBILITY STUDY
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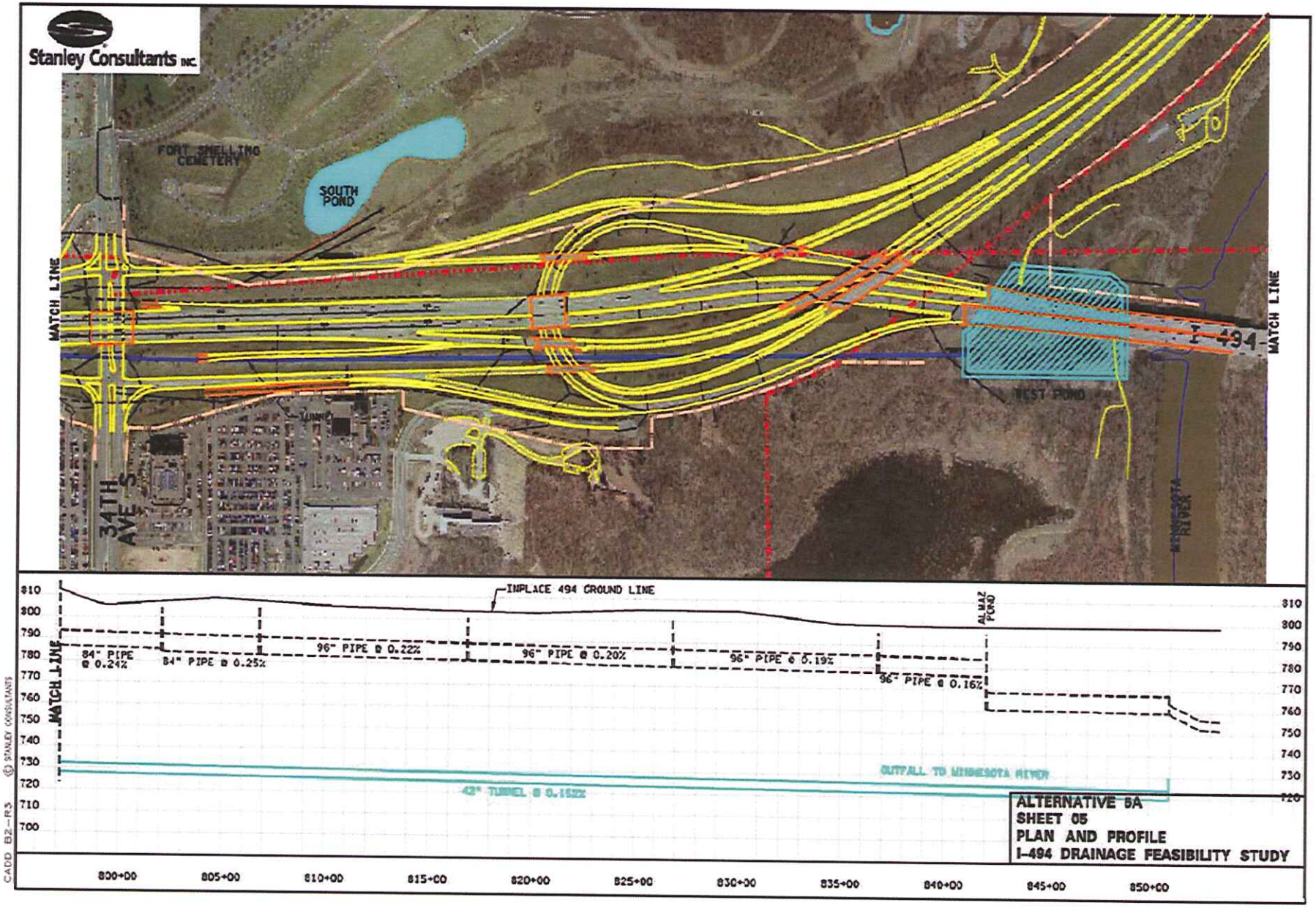
Stanley Consultants INC.
FORT SNELLING CEMETERY
SOUTH POND
MATCH LINE
34TH AVE S
TUNNEL
WEST POND
I-494
MATCH LINE
MINNESOTA RIVER
INPLACE 494 GROUND LINE
ALMAZ POND
84" PIPE @ 0.24%
84" PIPE @ 0.25%
96" PIPE @ 0.22%
96" PIPE @ 0.20%
96" PIPE @ 0.19%
96" PIPE @ 0.16%
OUTFALL TO MINNESOTA RIVER
42" TUNNEL @ 0.152%
810
800
790
780
770
760
750
740
730
720
710
700
800+00
805+00
810+00
815+00
820+00
825+00
830+00
835+00
840+00
845+00
850+00
ALTERNATIVE 5A
SHEET 05
PLAN AND PROFILE
I-494 DRAINAGE FEASIBILITY STUDY
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Alternative 5A

- Construction Cost $104.0M
- Property Costs $ 0.9M
- Maintenance Costs $ 0.5M
- Reconstruction (YR40) $ 2.4M

- Life Cycle Cost (80YR) $107.9M

Initial Construction Costs

Alternative 1C	$126.0M
Alternative 2C	$ 26.3M
Alternative 2D	$130.0M
Alternative 2E	$ 59.1M
Alternative 2F	$ 49.1M
Alternative 4A	$169.6M
Alternative 5A	$104.0M

Right-of-way Costs

Alternative 1C	$ 0.9M
Alternative 2C	$126.6M
Alternative 2D	$ 0.0M
Alternative 2E	$ 35.7M
Alternative 2F	$ 0.0M
Alternative 4A	$ 0.9M
Alternative 5A	$ 0.9M

Life Cycle Cost Summary (80YR)

Alternative 2F	$ 64.2M
Alternative 5A	$107.9M
Alternative 2E	$114.9M
Alternative 1C	$131.4M
Alternative 2C	$161.3M
Alternative 2D	$166.9M
Alternative 4A	$172.7M

Qualitative Factors

- Effect on neighbors
- Eliminate pump station
- Land Acquisition
- Local Politics
- Design storm event
- Loss of business
- Maintenance component to upstream sediment basins
- Maintenance concerns
- Non-degradation standards
- Above ground pond can be easier to clean
- Pond locations subject to change
- Ponds 20 feet below ground
- Rate control
- Resistance from Cities
- Timing
- Tradeoffs with Cities and Watershed Organizations
- Underground storage
- Volume reduction on municipal boundary basis
- Water Quality

Which Alternative? Pros and Cons.

- Flexibility
- Expandability
- Maintainability
- Constructability
- Costs to Adjacent Cities
- Residual Value of the System
- Capital Costs/Availability of Funding
- Design to Need/Design for longer time frame

Questions and Discussion