

Project Name | BCWD Permit Program: Pre-Permit

Date | Sept. 3, 2019

To / Contact info | Karen Kill, BCWD District Administrator

Cc / Contact info |

From / Contact info | Brett H. Emmons, PE (EOR); Kerri Robinson (EOR)

Regarding | TH 36/CSAH 15 Interchange Project - Stormwater Reuse Options (DRAFT)

Background

The Brown's Creek Watershed District (BCWD) has been in discussions with Washington County, Minnesota Department of Transportation (MNDOT), surrounding municipalities, and Applewood Hills Golf Course (AHGC) in a pre-permit collaboration role regarding alternative ways to manage the new runoff. Based on Washington County's experiences elsewhere and BCWD's interests, harvesting stormwater runoff from the proposed interchange project, and reusing it to supplement irrigation and offset groundwater withdrawal at the Applewood Hills Golf Course is being explored. In July of 2017, conversations began about the interchange with stakeholders as a study of the proposed interchange was commissioned. Subsequent meetings of the stakeholders, dubbed the Local Advisory Team (LAT), has consisted of review of study findings, evaluation of proposed interchange layout options, and community engagement opportunities.

By early 2019, Washington Co. and MNDOT had selected a preferred interchange layout and could begin focusing on the design, land acquisition, and pre-permitting aspects of the project. Recent discussions by BCWD have shifted to the possibility of harvesting and using the stormwater runoff (reuse) as a resource rather than a waste product. The approach would be to both provide volume control to benefit downstream flooding and water quality (without conflicting with infiltration restrictions in well head protection zones) as well as offset groundwater pumping of the aquifer for large scale turf irrigation.

A series of meetings were held to understand the perspective of potential stakeholders, gather input, and further vet the feasibility of the reuse option for stormwater treatment. The reuse project, as contemplated, could be the interchange project only, or it could be combined with other regional needs in the area, since other development is expected nearby. Some of the meetings that BCWD representatives were involved with in 2019 regarding stormwater and reuse include:

- Washington Co.-led Highway Design Team (Wash. Co., SRF, MNDOT, Stillwater) – Feb. 25
- Medical Campus Representative and City of Stillwater - Mar. 29
- Applewood Hills Golf Course and Washington Co. – Apr. 10
- MNDOT and Washington Co. – Apr. 24
- Applewood Hills Golf Course Site Visit – Apr. 24
- BCWD Board Meeting – Update and Check-in – May 8
- Washington Co.-led Design Team (Wash. Co., SRF) – July 11
- MNDOT and Washington Co. Team – Aug. 29

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On May 8, 2019 at the BCWD Board meeting, the Board heard a presentation given by Brett Emmons, EOR, and supported by Nathan Arnold, Washington County, updating them on the proposed interchange improvement project.

Following the presentation, the BCWD Board concurred that the District and EOR should continue to collaborate with the interchange project team. The next steps were to analyze the available runoff compared to the irrigation demands and available storage in the areas identified, in order to further assess the feasibility of implementing a stormwater reuse system on site. EOR's initial assessment of benefits and costs associated with capturing stormwater runoff from the proposed project area and some of the surrounding subwatersheds and using it to offset the well water demand for irrigation were encouraging. This memo summarizes the findings so that Washington Co., MNDOT, AHGC, and BCWD are able to evaluate the cost effectiveness of installing reuse ponds and altering the irrigation system to offset groundwater pumping in order to meet the District's rules.

Stormwater Reuse Principals and Approach

A harvest and reuse system is based on a water balance, comparing the harvested water supply (surface runoff), the storage (ponding), along with the demand (irrigation) in order to determine how much reduction in the current water source (groundwater) can be achieved. Once the source of water has been identified, the ability to capitalize on the new water source depends on the storage available at the times the runoff is occurring. These three factors, water supply, water demand, and storage, are the key aspects determining the performance and effectiveness of any harvesting and reuse system. EOR collected data from multiple sources including the BCWD, Washington County, and AHGC to characterize these three factors within the Stormwater Reuse Model.

- Water Supply/Source
 - Size of contributing watershed area
 - Soils mapping and geotechnical investigation
 - Land use characteristics of watersheds (i.e., impervious cover)
 - Existing storm sewer infrastructure
 - Precipitation records
- Water Demand
 - Sprinkler and irrigation line locations/irrigation coverage
 - Irrigation depth estimates
 - Precipitation records (to determine when is irrigation needed)
- Storage Options
 - Topography
 - Natural runoff flow paths
 - Existing waterbodies – nearby and on-site
 - Proposed or future ponding (for Hwy 36 interchange and corridor development)

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Stormwater Reuse Analysis

Existing Conditions

Applewood Hills Golf Course uses well water on-site to irrigate about 50 acres of greens and lawns from May to September/October. For this analysis, it was assumed the golf course would irrigate at a rate of 0.8 in/week. This is somewhat lower than typical lawn irrigation rates of 1.5 in/week. This reflects the golf course’s interest in conserving water to the maximum extent possible. Table 1 outlines the approximate annual irrigation demands of the AHGC under current conditions for a typical season.

Table 1 – Golf Course Existing Conditions Summary

Option	Irrigation Area (acres)	Pumped To Irrigation (ft ³ /yr)	% Reduction of Golf Course Groundwater Withdrawals	% of Surface Runoff Diverted from Contributing Area
Existing	50.3	2,420,295* (55.6 acre-feet)	0	0

*annual volume equates to over 27 Olympic sized swimming pools.

Other irrigation areas could have been explored. There is a nearby apple orchard and seasonal crops area with significant green space and potential for irrigation. Since the golf course is already a large water user and open to discussions, the apple orchard was not approached. If needed, that is another area that could be explored in the future. Also of note, any future development often has irrigation needs and could be a candidate for a reuse water demand area. An unorthodox, but also interesting idea could be irrigating, with a passive/drip system, the road right-of-way areas, since this is green space that would absorb and use the runoff water (via ET). The road ROW would not provide a water withdrawal savings, but is a large green space that is not being used expressly for any other need, aside from safety areas, maintaining visibility, and possibly habitat.

Proposed Project

The proposed interchange project includes the installation of a bridge, where CSAH15 can overpass TH36, as well as entrance and exit ramps to the highways, and stormwater facilities to contain runoff from the roadways. The area of the roadways and ramps directly draining to the stormwater facilities is approximately 37.5 ac, which includes a portion of the south corner draining golf course catchment (Figure 1).

According to the BCWD current rules, the stormwater management rules that the interchange needs to meet for the new and reconstructed impervious areas are as follows:

1. Match pre-settlement runoff rates for the 2-, 10-, and 100-year 24-hour events
2. Match the pre-settlement runoff volume for the 2-year, 24-hour event
3. Match pre-development annual TP load

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An alternative to the current rules has been discussed in the diversion portion of the watershed, which includes this site. An option the District has been discussing is the use of a minimum standard use elsewhere, the MIDS standards. For a linear project, the MIDS criteria suggests retaining 0.55" of runoff volume from impervious areas (instead of 1.1"). When applied to this site, based on the information provided at the time of assessment, a rough estimate of equivalent annual runoff volume retained for 0.55" requirement of MIDS. The estimate, in order to meet this MIDS rule (0.55"), would result in 61% of the annual runoff volume being retained.

The use of typical volume control practices that rely on *infiltration* recently has become an issue in this area. New guidance from the MPCA, under the updated NPDES permit, have identified the need to do additional analysis for infiltration proposed in Drinking Water Supply Management Area (DWSMA) where high or very high sensitivity is identified. Likewise, MNDOT has developed guidance on stormwater infiltration in its Technical Memorandum No. 14-06-ENV-01 titled Storm Water Infiltration System location guidelines for MnDOT ROW, dated July 9, 2014. The MnDOT guidance does not allow use of infiltration practices in their ROW in these higher risk areas. That guidance expires on July 9, 2019 but MnDOT has asked us to proceed under the existing guidance. While the use of infiltration may be overcome, these constraints have highlighted the interest in harvest and use/reuse as an alternative means of accomplishing stormwater volume control requirements in a new way. It is also interesting to note that the MIDS volume retention requirement, with various exception clauses, in an area where infiltration is not allowed, would result in 0% volume control.

The eastern side of the golf course has a low-lying area, which contains two pond features. The total area currently contributing runoff to potential ponding areas in the eastern side of the golf course is 61.4 ac. A portion of the golf course and frontage of TH36 (28.8 ac) drains south toward the project area and will be routed through and past the proposed interchange project. During the interchange project, this added area could be harvested by redirecting flows toward the Golf Course, or toward the NW interchange pond, but currently has not been included. This portion is not included in Options 1 and 2 (listed below) since it could be directed to either or neither set of ponds. The 28.8 ac portion of the golf course and frontage has been included in Option 3 so that all ponds and drainage areas are considered with a total contributing area of 119.29 ac.

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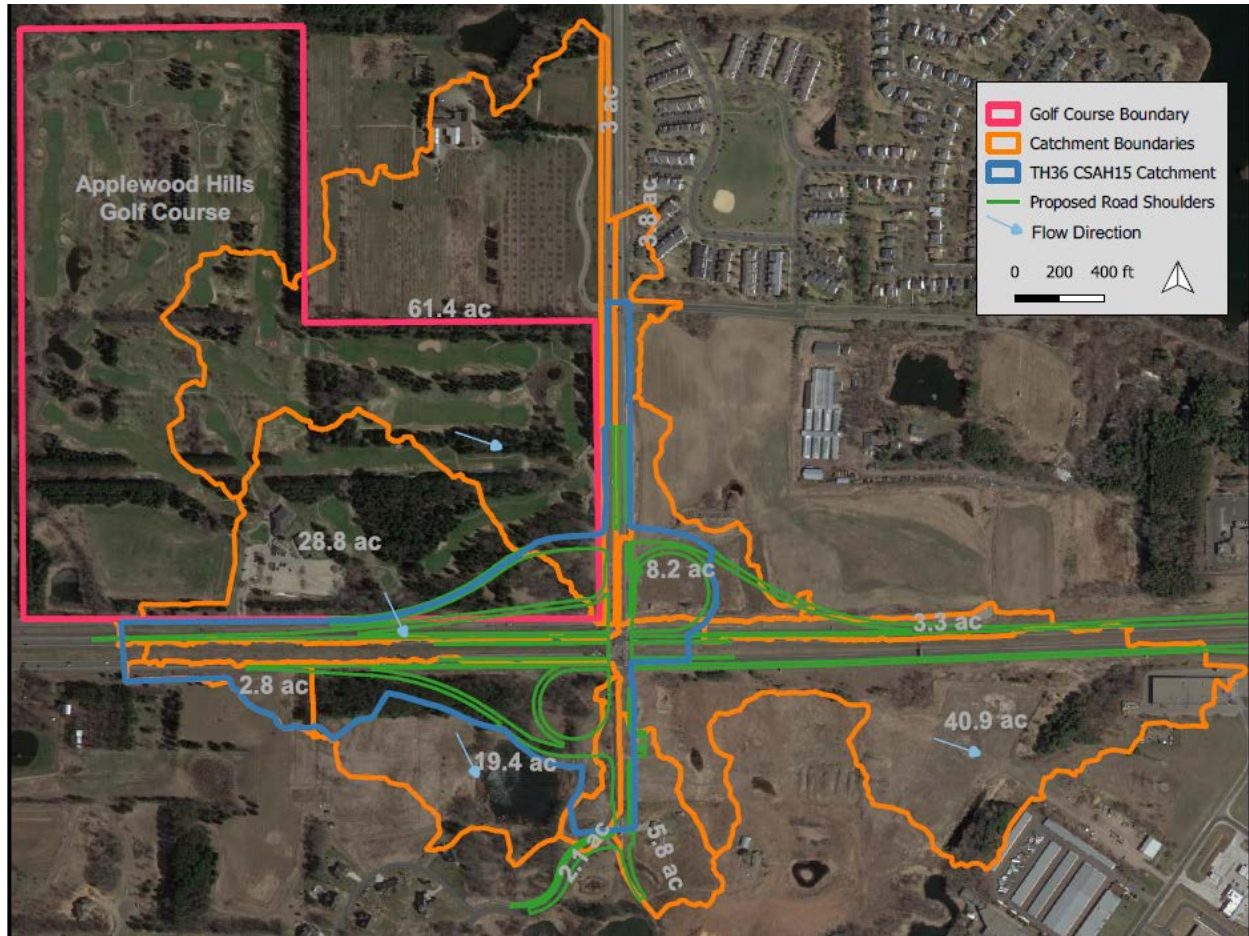


Figure 1 - Existing conditions with proposed TH36 and CSAH15 interchange overlay

Up to now, the interchange project team has been looking at alternative methods of compliance with the BCWD stormwater rules. The most recent approach has been to look at filtration ponding systems, used in other parts of the metro area. The filtration method is not at this point included in the BCWD Rules as alternative compliance and would require a variance in these situations, where infiltration is more difficult to accomplish due to regulatory issues, other methods will be needed and BCWD would consider filtration, as well as other methods. The filtration ponding systems initially proposed included smaller pretreatment basins, followed by sand filter beds in ponds with a draitile network below. This takes up a fair amount of space and requires on-going maintenance to preserve the sand bed filtration capacity.

Stormwater reuse is being explored to convert the two-cell ponding system (with filtration) to a one-cell pond, that might be smaller in footprint and less complicated. The ponding would pretreat the water before it discharges off the MnDOT ROW as well as provide needed storage for reuse.

Stormwater reuse modeling initially examined various conceptual scenarios that included various contributing areas, and using stormwater storage only within the proposed interchange project, only within the golf course, and combining the two systems to maximize available storage and source water runoff.

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EOR used a Stormwater Reuse Model developed for the MCWD and MWMO by EOR to assess the feasibility of stormwater capture and reuse for irrigation at the AHGC. The scenarios modelled are detailed below with graphics indicating the locations and sizes of each of the capture and storage facilities, and with summary tables of the key parameters and system performance.

- Option 1. Interchange Ponds - Construct stormwater ponds with the interchange project to capture stormwater runoff, pumping to AHGC for irrigation.
- Option 2. Golf Course Pond - Enhance existing ponding areas in Applewood Hills Golf Course and integrate into the irrigation system.
- Option 3. Linked Golf Course Pond and Interchange Ponds - Combine Options 1 and 2, using the enhanced existing ponds in AHGC and the constructed stormwater ponds to capture and retain larger amounts of stormwater for irrigation.

Option 1 – Interchange Ponds

In Option 1, the construction of the highway interchange project includes the construction of three ponds, located within the “clovers” of the interchange, plus a small pond to the south. The estimated grading of the interchange may allow hydraulic connection of all three ponds with a preliminary normal water level (NWL) of 952 ft in each pond. The contributing area of the interchange captures a portion of the southern golf course catchment area that currently drains south underneath the highway. In Option 1, the remaining portion of the south golf course catchment continues to drain under the highway to the south.

Under preliminary sizing and modeling, the ponds designed for reuse would have a 10 foot bench around the perimeter with a 10:1 slope, leading into a 3:1 slope, until the ponds reach a depth of 6 feet. The assumed depth of water available for irrigation would be 4’. (note: the footprints are for reference only as the active volume is more important than the footprint for reuse.) The details of constraints facing the locations and sizes of the ponds should be coordinated with the County and requires additional analysis and modelling during the preliminary design stage. Figure 2 illustrates the surface area required to capture runoff from the interchange. Table 2 lists the possible reduction in groundwater irrigation required if the interchange ponds are used for golf course irrigation.

Table 2 – Reuse Model Outputs for Option 1

SUMMARY OF OUTPUTS								
Option	Drainage Area Contributing Runoff (acres)	Pond(s) Volume for Irrigation (ft3)	Volume Captured From the Watershed (ft3/yr)	Stormwater Runoff that Overflows the Ponds (ft3/yr)	Stormwater Runoff Lost To Evaporation (ft3/yr)	Stormwater Runoff used for Irrigation (ft3/yr)	% Reduction of Golf Course Irrig. using Groundwater	% of Surface Runoff Diverted from Contributing Area
1	37.5	163,733 (3.76 acre-ft)	729,228	24,391	125,982	568,017	30%	97%

The benefits and drawbacks of this option are summarized as follows:

Benefits

- Irrigating from the proposed stormwater ponds provides around 30% of the annual irrigation requirements on average.
- Reduces groundwater withdrawal by approximately 4.2 million gallons (12.9 acre-feet) throughout the season during an average precipitation year (more volume than 6 Olympic sized swimming pools).
- Provides volume control within the DWSMA, and consistent with the BCWD volume control requirement.

Drawbacks

- Well water will be needed to make up the difference between the volume of stormwater available and the volume required for irrigation.
- Offset of irrigation needs equates to less than 50% (seasonal variables could make it less)
- Jacking a pipe under existing Hwy 36 adds cost to the project.

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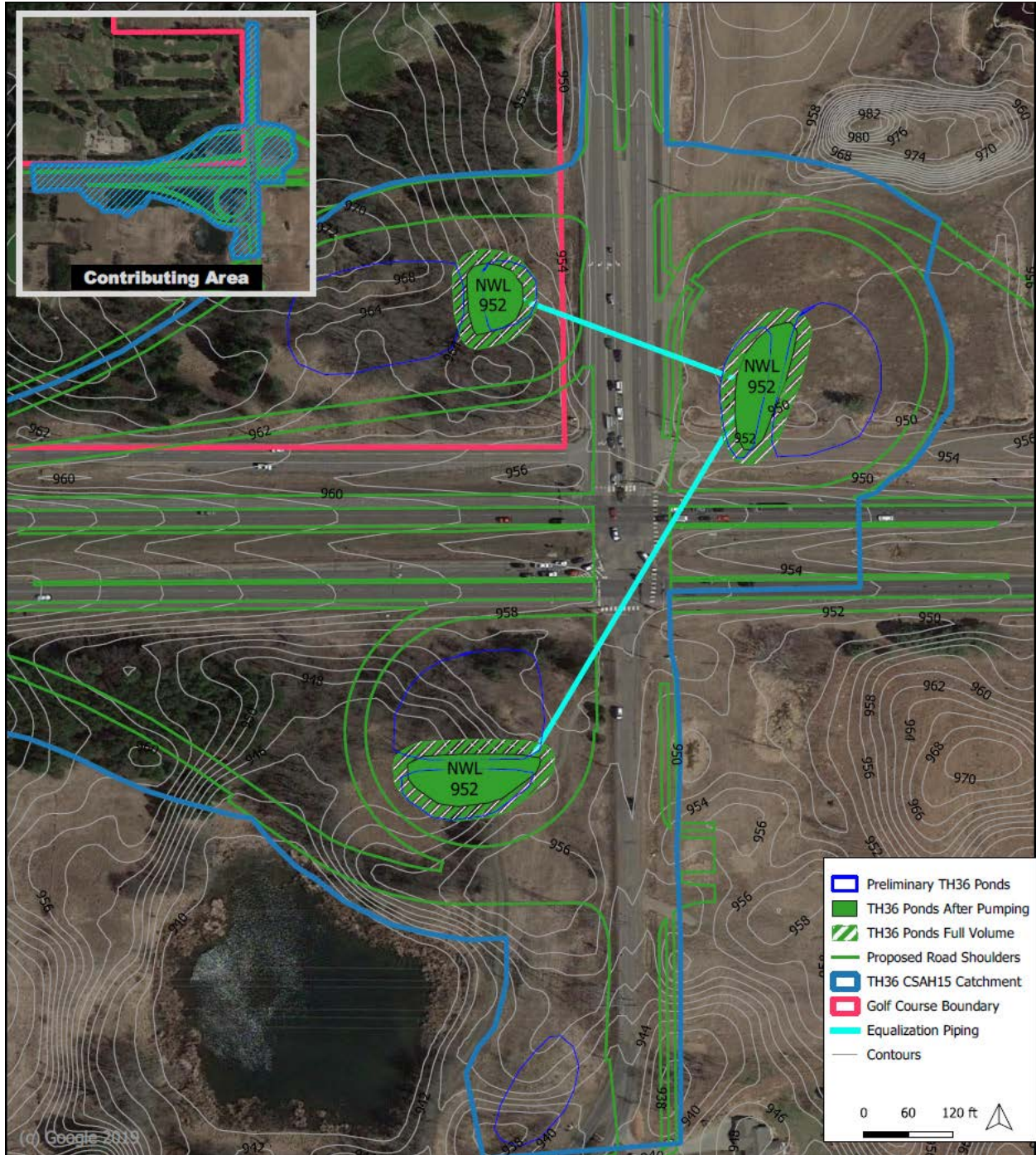


Figure 2 - Conceptual footprints and hydraulic connections of interchange ponds compared to preliminary layouts

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Option 2 – Golf Course Pond

Due to the topography of the region and the golf course, the existing location of the ponding areas along Manning Ave./CSAH15 is ideal for stormwater capture. Given the size of the drainage area, the ponds could be expanded to allow for increased storage volume. Since the golf course has been interested in making improvements to the north and south ponds, these improvements have been incorporated into our analysis.

Figure 3 indicates the general surface area required for the south pond. Under preliminary modeled conditions, the enhanced pond would have a 10 foot bench around the perimeter with a 10:1 slope, leading into a 3:1 slope, until the ponds reach the desired depth of 6 feet. The pond shown should not be considered final and its location and configuration is subject to the AHGC input and approval. The details of constraints facing the location and size of the pond requires additional analysis and modelling during the preliminary design stage.

Table 3 outlines the approximate reduction in groundwater achieved by capturing surface runoff from the catchment that currently drains toward the potential golf course pond, from both the orchard and the golf course. The south golf course catchment currently drains toward the highway and could possibly be diverted to the pond, but a high point between the current flow path and the pond would have to be re-contoured to enable that option. The model does not include contributions from the south catchment.

AHGC uses a variable speed pump located above ground at their maintenance facility to draw groundwater from their well and then push it into the system for irrigation. The golf course's current configuration does not include an irrigation pond. An option to add a second, valved intake to pull water from the stormwater pond system when it is available, should be pursued. In that configuration, a level indicator and an automatic shut off control to switch back to the groundwater source when the pond volume available has been used up. Water level indicators and shut off systems are fairly typical in irrigation pond configurations such as found at golf courses. This type of irrigation configuration would also apply to the golf course ponds in Option 3.

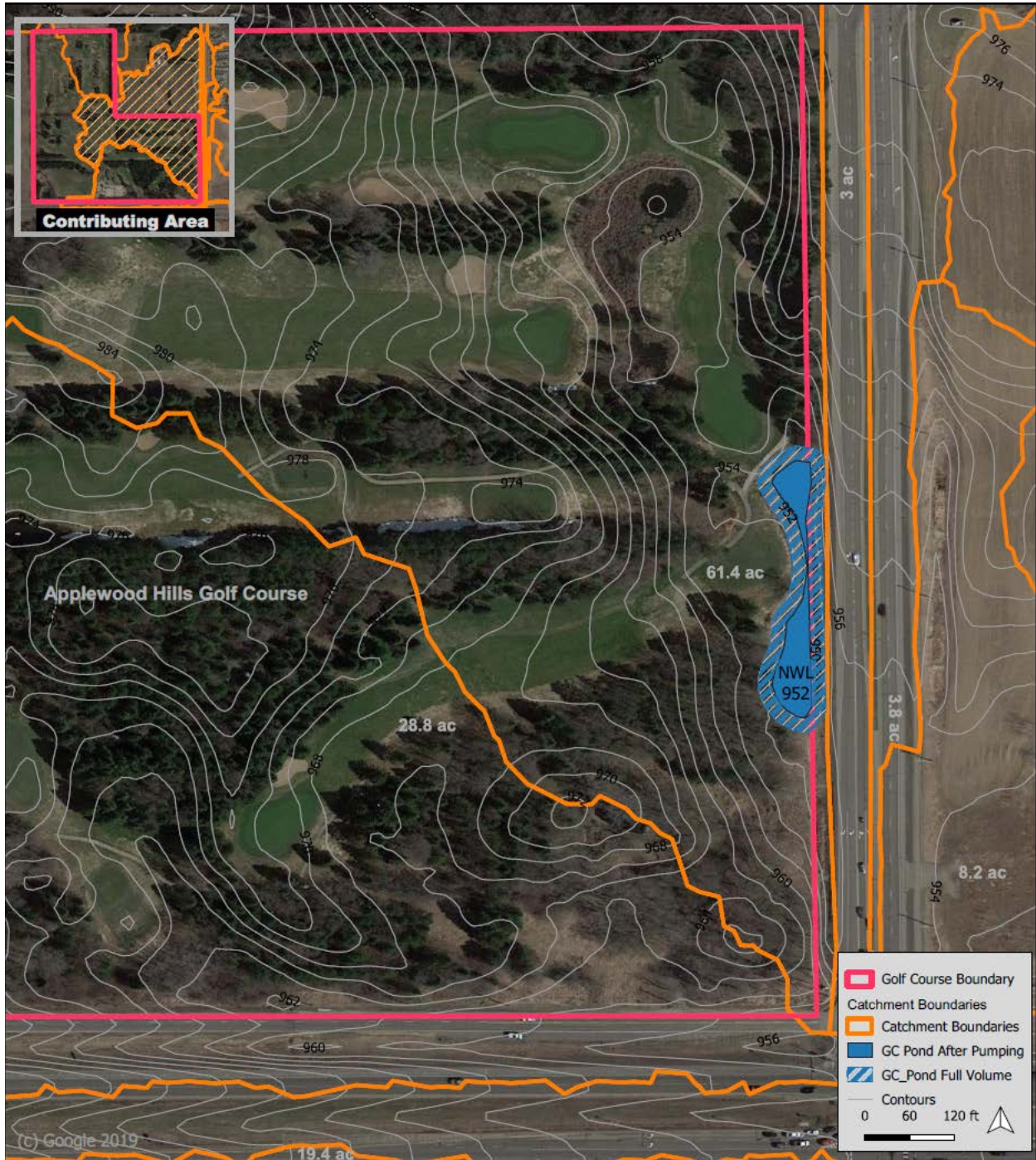


Figure 3 – Conceptual location of AHGC stormwater pond

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Table 3 – Reuse Model Outputs for Option 2

SUMMARY OF OUTPUTS								
Option	Drainage Area Contributing Runoff (acres)	Pond(s) Volume for Irrigation (ft3)	Volume Captured From the Watershed (ft3/yr)	Stormwater Runoff that Overflows the Ponds (ft3/yr)	Stormwater Runoff Lost To Evaporation (ft3/yr)	Stormwater Runoff used for Irrigation (ft3/yr)	% Reduction of Golf Course Irrig. using Groundwater	% of Surface Runoff Diverted from Contributing Area
2	61.35	35,799 (0.82 acre-ft)	134,624	14,375	30,589	100,108	6%	89%

The benefits and drawbacks of this option are summarized as follows:

Benefits

- Pond is naturally located to intercept stormwater runoff and minimize disturbance to the golf course.
- Irrigating from the proposed stormwater pond provides around 6% of the annual irrigation requirements on average.
- Reducing groundwater withdrawals by approximately 0.75 million gallons (2.3 acre-feet) throughout the season during an average precipitation year (more than 1 Olympic sized swimming pool).
- Provides volume control within the DWSMA and treats runoff not subject to current requirements.

Drawbacks

- The pond is relatively small and large storm events overflow the ponds.
- Well water will need to make up the difference between the volume available and the volume required.
- Gravity flow from the stormwater ponds is not possible for irrigation necessitating the installation of a valved intake with level indicator and automatic shutoff control to the existing irrigation system.
- Does not capture much runoff from the interchange project.
- Pond will likely be impacted/reduced by the road project.

Option 3 – Linked Golf Course Pond and Interchange Ponds

The final option is a combination of Options 1 and 2, wherein the pond in AHGC is enhanced to provide additional storage, the stormwater ponds are constructed for the highway interchange project, and the systems are connected to harvest, retain, and reuse stormwater to irrigate the golf course. Based on the elevations, a NWL of 952 would allow the golf course pond to be hydraulically connected with the NE and SW ponds, allowing pond level equalization. This connection with the golf course pond should have a gate on it to prevent connections in the event of a highway spill or other emergency that could allow pollutants to pass to the golf course pond.

The preliminary system, as shown here, connects the northeast interchange pond to the south pond of the golf course. Overflow from the south pond of the golf course could be routed in the same configuration as it currently is, or as MnDOT determines. The proposed dimensions of the ponds remain the same as proposed in Options 1 and 2. Table 4 lists the possible groundwater demand reductions achievable if stormwater collected in these ponds is used for AHGC irrigation.

The easiest place to capture runoff from the south golf course catchment is in the NW interchange pond. Figure 4 indicates two potential flow paths for the catchment and a potential expanded footprint of the NW interchange pond to accommodate the increased volume coming from that portion of the golf course. Alternately, the southern portion of the golf course pond could be expanded to the west to accept that volume.

Table 4 – Reuse Model Outputs for Option 3

SUMMARY OF OUTPUTS								
Option	Drainage Area* Contributing Runoff (acres)	Pond(s) Volume for Irrigation (ft3)	Volume Captured From the Watershed (ft3/yr)	Stormwater Runoff that Overflows the Ponds (ft3/yr)	Stormwater Runoff Lost To Evaporation (ft3/yr)	Stormwater Runoff used for Irrigation (ft3/yr)	% Reduction of Golf Course Irrig. using Groundwater	% of Surface Runoff Diverted from Contributing Area
3	119.29	199,531 (4.58 acre-ft)	1,205,345	238,983	104,806	827,285	41%	80%

*Option 3 includes capture of runoff from the full south portion of the golf course (28.8 ac.) which, when combined with the interchange catchment area and the golf course pond catchment area totals 119.29 ac. The interchange catchment area (Option 1) overlaps the south golf course catchment and so the total contributing area in Option 3 is less than the sum of Option 1 and Option 2 plus the full 28.8 ac of the south golf course catchment area.

The benefits and drawbacks of this option are summarized below:

Benefits

- Irrigating from the proposed stormwater ponds provides around 41% of the annual irrigation requirements on average.
- Reducing groundwater withdrawals by approximately 6.2 million gallons (19 acre-feet) throughout the season during an average precipitation year (more than 9 Olympic sized swimming pools).
- Regional approach with most flexibility to enhance treatment across multiple jurisdictions.
- Reduces operation and maintenance for MNDOT compared to the filtration ponds.
- Best fits the goal of beneficial reuse of stormwater runoff and sustainable water management.
- Provides volume control within the DWSMA, and consistent with (and/or exceeds) the BCWD volume control requirement.

Drawbacks

- Hydraulic modelling will be required to ensure that the ponds can be connected by gravity and equalization piping.

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- Need to expand ponds within the interchange to maximize volume, which may also affect safety layout issues.
- Jacking a pipe under existing Hwy 36 adds cost to the project.

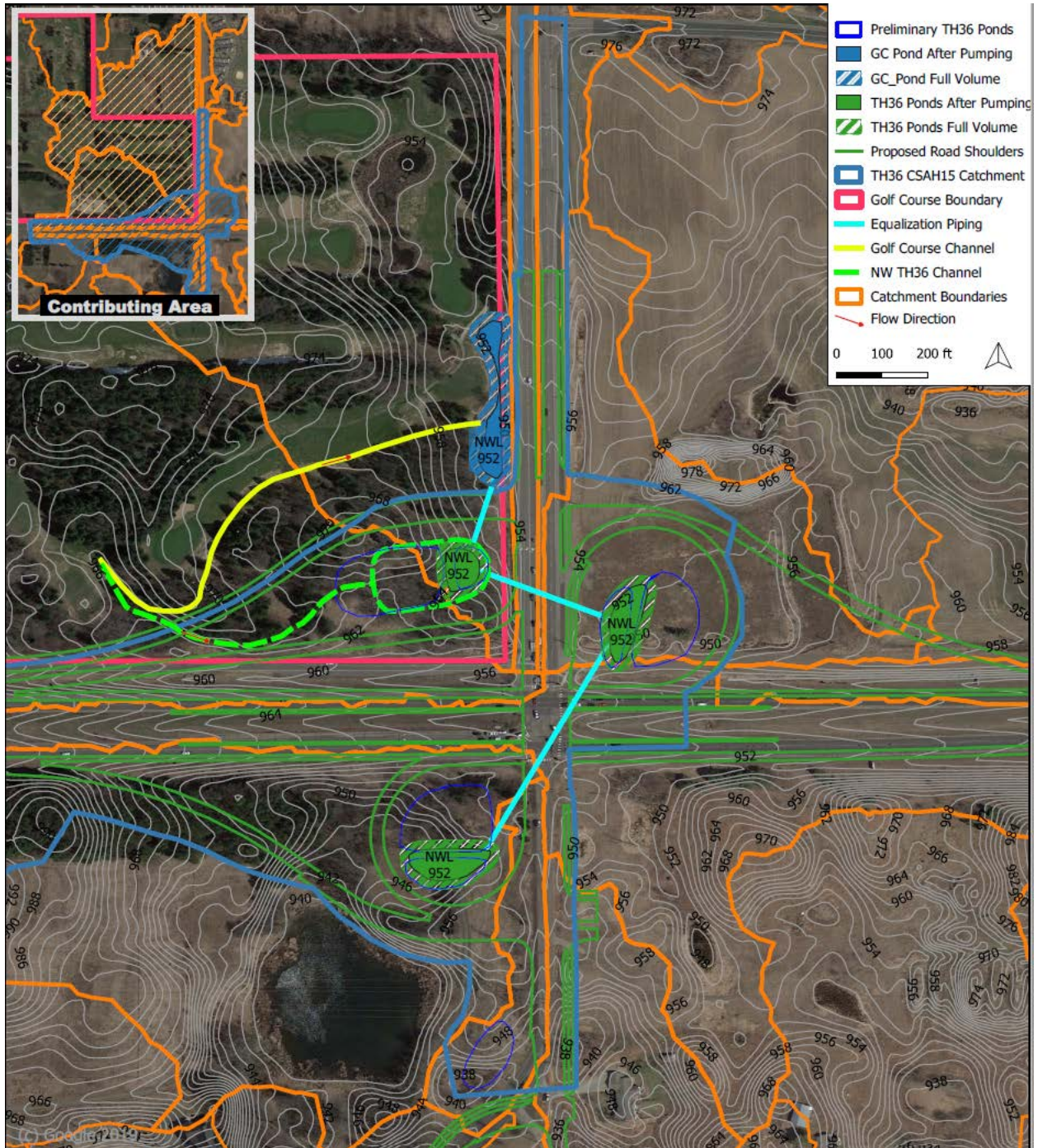


Figure 4 - Conceptual combination of golf course and interchange ponds

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Additional Options to Store or Capture Additional Volume

As Options 1-3 were being developed, there were additional options encountered that could be included to expand the effectiveness and efficiency of reducing surface runoff downstream and offsetting irrigation groundwater pumping. These options, listed below, were not included in the options detailed in this memo but may be worth considering as the design moves forward.

Larger Interchange Ponds

The volume of the interchange ponds could potentially be increased to accommodate increased stormwater storage. This is primarily in the situation where runoff from adjacent areas is part of the project. The footprint of the ponds could be expanded, or if determined to not pose an increased public safety risk, the bench slope requirements could be modified to allow for increased depth and volume within the ponds. Guard rails in some areas may be a consideration.

Interchange Project South Pond

The preliminary plan provided by Washington County shows the construction of an additional, smaller stormwater pond located to the south of the interchange, on the west side of Manning Ave. This pond could be connected to the other interchange ponds, and used to provide additional volume. Due to the limited footprint of this proposed pond, the cost-benefits of installing a pond here should be assessed.

Interchange South Pond Connection to Existing Basin

Directly to the west of the proposed south pond is an existing depression, which has a surface area of approximately 2.5 ac. The south pond could be expanded to join with the existing large depression, allowing for significantly increased storage area. This may be more relevant if additional areas of future development were connected to this system.

Additional Golf Course Ponds

There are two possible options to increase storage volumes on the AHGC. North of the proposed golf course pond is a basin that collects water that could be deepened to expand on a second ponding area that would drain south by gravity into the pond proposed here. Additionally, the pond could be expanded to the west in the southern portion to add more storage capacity. The golf course has indicated that the east side of the pond stays wet often, not ideal for play, and regrading and reconfiguring that area could serve a benefit to both the golf course and the ponding needs.

Regional Treatment Opportunities

There is planned development in several areas adjacent to this project and is part of the reason for the need for the interchange improvements. The layout could provide some flexibility to connect other areas as development occurs. This would have the benefit of providing an alternative treatment method to satisfy stormwater requirements for those developments, similar to concepts being implemented in Waconia and elsewhere currently. The regional approach here could help satisfy stormwater requirements along with challenges of volume control in the DWSMA protection areas, while at the same time providing simplicity, certainty for developing parcels, less cost, and possibly free up land for development. On the water supply side, this could allow more water

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available for irrigation, above the projected 40%, and more fully off-set the golf courses groundwater needs, thus providing a more resilient system and reducing demands on the aquifers.

South Golf Course Catchment

A portion (28.8 ac) of the golf course and TH36 drains south under existing conditions through the proposed interchange project area (see Figure 1). In the event that Option 3 is not selected, this portion could be redirected toward the Golf Course as part of Option 1, or toward the NW interchange pond as part of Option 2, during construction of the interchange. The current modelling does not reflect this additional drainage area in Options 1 and 2.

Conclusions

The analysis indicates that reductions in groundwater pumping for irrigation on the golf course could range from 6% to 40% (Table 5) on average depending on the scenario. Table 6 relates the costs to construct each Option with the approximate reduction in average groundwater being used by the golf course. Use of stormwater ponds and reuse intercepts stormwater runoff that would normally drain to Long Lake and ultimately head toward McKusick Lake, the St. Croix River and occasionally Brown's Creek (by-pass overflows).

The plan is to pursue Option 3 after input from Washington Co. and MNDOT, including the larger drainage area and providing more source water for irrigation. The recent work of the interchange design team has further adjusted the layout from the three options shown here. The golf course pond shown in Option 3 will likely be impacted by the project and therefore would not be included, but additional storage would be accommodated in the interchange ponds. If the material being excavated can be used for the road project, enlarging the interchange ponds could have a secondary benefit. The final configuration being considered may vary slightly from that shown, but the basic parameters of drainage area and pond capacities are similar.

MNDOT has indicated it would not operate any reuse facilities, but could have its discharges from its ponding area go to a reuse system. Initial cost estimates for the ponding inside the interchange project, as part of a reuse configuration, indicate cost savings over the filtration ponds being proposed. This is apart from the pumping or filtering needed to transfer the water into the irrigation system, something that would be part of facilities operated and owned by another entity. That cost savings consists of both initial capital costs to construct the facilities as well as operation and maintenance costs. The concept is that MNDOT/Washington Co. could contribute financially (e.g., cost savings) toward the separate portion of building the pumping and filtering system. The performance of this reuse system would greatly out

Reductions in well water pumping for irrigation may be lower than modelled due to losses along the irrigation lines and other constraints within the golf course. Additional work with the golf course staff to understand their irrigation layout, pumping, zones, and operation will be needed to further refine how best to integrate this additional water source. Since the golf course pumps directly into their system using a variable speed pump, incorporating the runoff into their irrigation system warrants further review.

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Next Steps

The next steps necessary to move this concept forward will require continued discussions and collaboration between the Washington County design team (County staff and SRF), MNDOT, Applewood Hills Golf Course, BCWD, and EOR. Items for further investigation:

1. Integration of the stormwater sources into the golf course irrigation system.
 - How and where irrigation zones established and managed on the golf course.
 - How to integrate pumping and optimized to draw water from surface water ponds?
2. Coordination with the AHGC and further design, including more explicit model, of selected capture and reuse option.
3. Discuss and agree on cost-sharing options with partners, along with responsibilities of entities (ownership and O&M)
4. Is a regional stormwater reuse approach an option for further consideration?
 - Allow future flexibility, would runoff from new developments adjacent to the highway be feasible to include? Including future areas in a regional stormwater system could significantly reduce the amount of groundwater required on the golf course and may be highly desirable for the developers, as well for city street projects.

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Table 5 - Summary of Stormwater Reuse Scenarios

SUMMARY OF OUTPUTS									
Option	Summary	Drainage Area (acres)	Runoff From the Watershed (ft3/yr)	To Overflow (ft3/yr)	To Evaporation (ft3/yr)	To Irrigation (ft3/yr)	% Reduction of Golf Course Irrigation using Groundwater	% of Surface Runoff Diverted to Pond from Contributing Area	% of Surface Runoff Diverted from 119 Acre Subshed
Existing	Existing Conditions	119.29	0	0	0	2,420,295			
1	Interchange Ponds	37.5	729,228	24,391	125,982	568,017	30%	97%	58%
2	Golf Course Pond	61.35	134,515	14,336	30,589	100,108	6%	89%	10%
3	Linked Golf Course Pond and Interchange Ponds	119.29	1,205,345	238,983	104,806	827,285	41%	80%	80%

Table 6 - Summary of Stormwater Reuse Costs

SUMMARY OF PERFORMANCE AND COSTS						
Option	Option Name	Drainage Area (acres)	Pond Volume (ft3)	To Irrigation (ft3/yr)	Estimated Cost* (Design & Construction)	Cost/Unit Runoff Diverted to Irrigation (\$/CF)
1	Interchange Ponds	37.5	163,733 (3.76 af)	568,017 (13.04 af/yr)	\$153,000	\$0.27
2	Golf Course Pond	61.35	35,799 (0.82 af)	100,108 (2.30 af/yr)	\$242,000	\$2.42
3	Linked Golf Course Pond and Interchange Ponds	119.29	199,531 (4.58 af)	827,285 (18.99 af/yr)	\$260,000	\$0.31

*Costs associated with the ponds and linking ponds within the interchange are not included here (to be included in Co./MNDOT infrastructure as similar to previous design). Cost estimates for pumping to/into the irrigation system (& filters) is based on very limited information from the golf course and could vary substantially.

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