

Technical Memorandum

To: Nick Tomczik, Interim District Administrator
Rice Creek Watershed District

From: Joseph A Lewis, PE
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Through: Chris Otterness, PE

Subject: RCD 4 Water Management Project Feasibility

Date: September 30, 2019

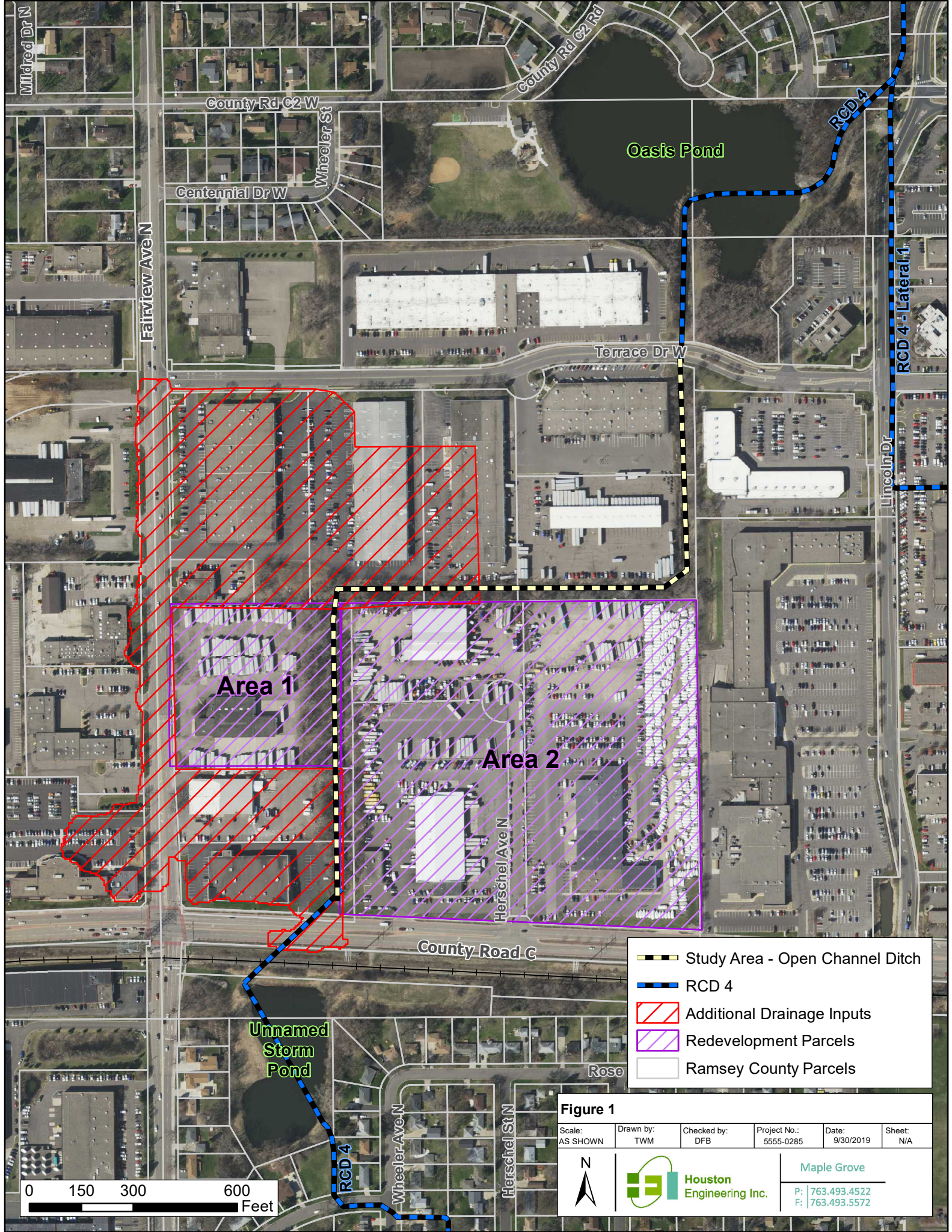
Project: 5555-0285

INTRODUCTION

The purpose of this report is to summarize the evaluation of the feasibility and effectiveness of incorporating stormwater management measures along Ramsey County Ditch 4 (RCD 4) between County Road C and Terrace Drive. Four properties adjacent to RCD 4 are in various stages of the redevelopment process and are shown on **Figure 1**. The parcels are currently developed as heavily commercial and industrial land uses and have been proposed to be redeveloped into a mixed use of multi-family residential housing and light commercial land use. The City of Roseville (City) has requested the Rice Creek Watershed District (RCWD) to investigate the feasibility of replacing the RCD 4 open channel ditch between County Road C and Terrace Drive with stormsewer pipe to make the area more conducive to redevelopment plans. Closure of the open channel also has the potential to reduce future maintenance cost of the RCD 4 public drainage system and downstream conveyance of sediment to the Oasis Pond sediment basin (one of the RCWD's District Facilities). However, RCWD is not readily equipped to maintain extensive lengths of storm sewer. Besides the closure of the open channel, the RCWD has an associated interest in evaluating the feasibility and effectiveness of collaborating with the City and adjacent landowners to implement water quality treatment and flood storage in excess of the RCWD Rule C stormwater management requirements. This technical memorandum describes the existing RCD 4 drainage system in this area, the sizing and cost of installation of replacing the open channel with stormsewer, the analysis and results of incorporating water quality and flood storage on the redeveloping properties.

EXISTING CONDITIONS

RCD 4 is currently comprised of an open channel between County Road C and Terrace Drive. In some locations the open channel bottom is nearly twenty feet lower than the surrounding area, with steep side slopes. Open channel side slopes this steep that are not armored are highly susceptible to








-  Study Area - Open Channel Ditch
-  RCD 4
-  Additional Drainage Inputs
-  Redevelopment Parcels
-  Ramsey County Parcels

Figure 1

Scale: AS SHOWN	Drawn by: TWM	Checked by: DFB	Project No.: 5555-0285	Date: 9/30/2019	Sheet: N/A
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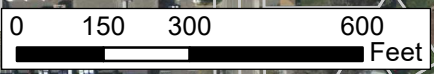




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erosion and bank failures as evidence by bank sloughing and blow-outs along this portion of RCD 4 in recent years. In severe cases, bank failures can create ongoing maintenance needs, damage structures, infrastructure or property, as well as create safety hazards. The potential for these failures, along with the right-of-way necessary for the Drainage Authority to maintain the open channel, diminishes the developable area of the adjacent parcels based on the required maintenance corridor for excavation of the open ditch and spoil placement.

The upstream watershed area of 465 acres is developed with a mix of single family housing, residential and industrial/commercial land uses. Immediately upstream of the project location on RCD 4 is a 78-inch reinforced concrete pipe (RCP) crossing under County Road C. Upstream of the County Road C crossing is an unnamed stormwater pond which receives runoff from the upstream RCD 4 watershed and local stormsewer. At Terrace Drive (the downstream end of the project location) the crossing is a 10-foot wide by 6-foot high reinforced concrete box culvert. RCD 4 continues downstream from Terrace Drive for approximately 300 feet before reaching the sediment basin at Oasis Pond, a District Facility.

REPLACE OPEN CHANNEL WITH STORM SEWER

HYDRAULIC ANALYSIS

Analysis was done to determine a hydraulically equivalent pipe to replace the existing open channel between County Road C and Terrace Drive. Several stormsewer pipe sizes were evaluated using the hydraulic modeling software XPSWMM to estimate flood elevations upstream and downstream of the RCD 4 channel. The existing conditions XPSWMM model was directly adopted from the RCWD's District Wide Modeling Program (DWMP). **Table 1** below displays how the various proposed pipe sizes affect flood elevations.

Table 1 - 100-year, 24-hour Peak Flood Elevations (feet¹) Upstream of County Road C and Downstream of Terrace Drive

Scenario	Upstream Flood Elevation	Downstream Flood Elevation
Existing Open Channel	917.22	898.20
7-ft RCP	916.94 (-0.28)	898.30 (+0.10)
6-ft x 8-ft RCBC	916.77 (-0.45)	898.32 (+0.12)
8-ft x 4-ft RCBC	918.26 (+1.04)	898.08 (-0.12)
6-ft x 6-ft RCBC	917.56 (+0.34)	898.20 (+0.00)

The existing floodplain upstream of County Road C inundates a City street (Rose Place) and is within two feet of the lowest opening of an adjacent home. Therefore, projects must not increase the peak flood elevation at this location. Downstream of Terrace Drive at Oasis Pond, the 100-year flood does

¹ All elevations provided herein are based on North American Vertical Datum of 1988 (NAVD 88)

not inundate adjacent roadways or buildings, though any increase in peak flood elevation should be limited to avoid increased flow in portions of RCD 4 further downstream. Two of the modeled scenarios (4-ft (h) x 8-ft (w) and 6-ft (h) x 6-ft (w) reinforced concrete box culverts) are infeasible as they increase upstream peak flood elevations. The 7-foot RCP and 6-ft (h) x 8-ft (w) RCBC are both hydraulically feasible as they result in decreases in upstream flood elevation, and minimal increases (~0.1') downstream at Oasis Pond for a 100-year, 24-hour rainfall event.

PROJECT BENEFITS

There are several benefits to replacing the open channel ditch with stormsewer pipe as proposed:

- Public Drainage System - Replacement of the existing open channel with a pipe will substantially reduce future maintenance costs. The current ditch has up to two feet of sediment accumulated in the bottom, which requires removal to restore function. Trees and brush growing out of the side slopes of the ditch also decrease the efficiency of the ditch. Maintenance of the system is infeasible until trees are cleared and landowner intrusions are removed to accommodate access. Replacing the open channel with a pipe will negate the need for a major repair, and will reduce or eliminate other localized failure, including blow-outs of the ditch bank.
- Oasis Pond Sediment Basin – This District Facility was designed to capture sediment in RCD 4 in a location that could be effectively maintained through dredging. Much of the large sediment accumulating in this sediment basin is a result of erosion from the side slopes and banks of the RCD 4 open channel, as evidenced by pond and channel bank blow-out in 2014 which resulted in a plume of sediment into the sediment basin. Replacing the open channel with a pipe will substantially decrease the frequency of required dredging operation by the RCWD in the Oasis Pond Sediment Basin.
- Water Quality – As noted above, replacing the open channel with a pipe will reduce streambank erosion and downstream sediment delivery. This will likewise result in a reduction in downstream TP delivery to the lower portions of RCD 4 and into Little Johanna Lake.
- Upstream Flooding – Since the surface roughness of a concrete pipe is substantially less than the existing open channel, there is the opportunity to reduce flood elevations upstream of County Road C (a location identified to be at risk of roadway and structural flooding) by as much as a half-foot.
- Property Value and Function – Replacing the open channel with a pipe will reduce the width of property along adjacent properties that is encumbered by the ditch (i.e. the right-of-way). This could result in additional developable land on these parcels and open up opportunities for alternative land uses in the current footprint of the ditch, such as greenways and trails.
- Public Safety --Replacing the open channel reduces potential hazards resulting from the steep embankment slopes and relatively deep open channel ditch, approximately 15-20 feet, in a heavily developed area.

PRELIMINARY COST ESTIMATE

The cost to replace the open channel between County Road C and Terrace Drive was estimated for planning purposes. Fill material will be required to nearly fully fill the open channel so that the pipe is adequately covered, surface drainage is accommodated, and grades do not inhibit maintenance or adjacent uses. (This estimate assumes that the channel is filled to an elevation similar to the surrounding area). The cost provided below does not include landscaping or other amenities required for a specific land use. **Table 2** below displays these estimated costs.

Table 2 – Stormsewer Preliminary Cost Estimate

Item	Unit	Unit cost	Quantity	Cost
MOBILIZATION	LS	\$100,000	1	\$100,000
84-INCH RCP*	LF	\$750	2,425	\$1,818,750
IMPORTED FILL**	CY	\$15	46,200	\$693,000
INTAKES	EA	\$5,000	6	\$30,000
MANHOLES	EA	\$50,000	4	\$200,000
CONNECT TO EXISTING LATERAL	EA	\$5,000	6	\$30,000
CLEARING AND EROSION CONTROL	LS	\$50,000	1	\$50,000
			Construction Cost	\$2,921,750
			Contingency (25%)	\$730,438
			Total Cost	\$3,652,188

*Replacing with a 6-ft x 8-ft RCBC is estimated to add an additional \$750,000 to the cost

**Utilizing excess fill from adjacent land parcels (if available) may reduce this cost

STORMWATER BMPS ON REDEVELOPING PARCELS

Much of the land development with the RCD 4 watershed occurred prior to modern water quantity and quality rules and standards, and as a result there is a minimal amount of stormwater storage volume available. Understanding that relatively few locations are available within the RCD 4 contributing watershed for stormwater management retrofitting, the RCWD is attentive to identifying opportunities for creating additional stormwater storage and treatment on the landscape. Large-scale redevelopment sites, and particularly those that are located near the public drainage system, are potential candidates for stormwater retrofitting.

As noted above, several properties along RCD 4 between County Road C and Terrace Drive are at varying stages of redevelopment planning. RCWD Rule C requires that 1.1 inches of runoff over the impervious surface created or reconstructed through redevelopment on these sites must be treated through stormwater BMPs (either on site or on a regional basis). In addition, the projects must reduce the peak runoff rate from the site by 20% from existing conditions. These rule requirements alone will contribute towards reducing peak flows and discharge of sediment and nutrients downstream.

However, given the proximity of these redevelopment sites to RCD 4, there may be opportunity to create additional storage and treatment volume beyond the Rule requirement, to provide regional stormwater management needs. The following analysis investigates the feasibility of these sites for regional treatment.

ANALYSIS

Figure 1 identifies sites on the west and east side of RCD 4 (denoted as “Area 1” and “Area 2”, respectively) currently proposed for redevelopment. The purpose of this analysis is to determine 1) the practical maximum volume that can be created on each of these sites, in excess of RCWD Rule requirements; 2) the maximum land area that can practically be treated by these sites; and 3) the effectiveness of stormwater management in excess of Rule C on the flood elevations downstream of Terrace Drive and on downstream sediment/nutrient loading.

The analysis assumes that the open channel ditch has been replaced with a stormsewer pipe between County Road C and Terrace Drive. The analysis also assumes that underground stormwater chambers are used for on-site treatment (both for meeting Rule C requirements and for developing excess regional treatment/management). These types of devices are commonly used in underground BMPs within the watershed.

Table 3 shows the required volume of water treatment for the proposed redeveloped areas, and the potential available storage. **Table 3** also displays the impervious surface area required for treatment under the Rule, and additional impervious surface area that may potentially be treated through these storage areas. There are a couple of challenges to utilizing the site for regional stormwater management:

- RCD 4 is very deep compared to the adjacent landscape, and it would be cost-prohibitive to constructed stormwater management facilities at a depth equivalent to the bottom of the ditch. Therefore, there is very little opportunity to direct flow from RCD 4 into adjacent BMPs, particularly for small rainfall events.
- The local drainage area to RCD 4 between County Road C and Terrace Drive is relatively small, consisting primarily of the parcels that back directly onto the ditch. As a result, there is very limited ability to direct offsite flow into the stormwater management facilities on the redevelopment site (an additional 17.08 acres of impervious surface.)

Table 3 – Impervious Area and Treatment Volumes

Location	Area 1 (west)	Area 2 (east)	Totals
Existing Condition Impervious Area (acres)	3.81	21.29	25.1
Estimated Impervious Area After Redevelopment (acres)	3.79	13.9	17.69
Rule C Treatment Volume (cubic feet)	30,250	111,000	141,250
Runoff depth treated under Rule C (inches)	2.2	2.2	2.2
Other impervious surface area available for treatment (acres)	4.21	12.87	17.08
Additional Available Treatment Volume (cubic feet)	46,790	199,225	246,015
Additional Runoff Depth treated for Maximum Estimated Storage Volume (inches)	2.7	3.2	3.1

Tables 4 and 5 below display the effect of this additional storage and release on RCD 4, specifically on flooding at Oasis Pond.

Table 4 – Downstream Flood Elevation at Oasis Pond (ft)

Event	Existing Conditions	With Rule C Requirements on Redeveloped Parcels	Additional Storage
2-year	896.01	896.01	896.01
10-year	896.64	896.49	896.47
100-year	897.78	897.52	897.18

Table 5 – Peak Flows Leaving Oasis Pond (cfs)

Event	Existing Conditions	With Rule C Requirements on Redeveloped Parcels	Additional Storage
2-year	289	290	291
10-year	385	358	355
100-year	580	535	467

RESULTS – RELATIVE BENEFIT OF ADDITIONAL STORAGE

Adding additional storage beyond Rule C requirements can provide a marked reduction in flood elevations at Oasis Pond for the 100-year rainfall. However, during more frequent storm events, there is virtually no benefit in flood reduction or decrease in downstream flows from additional storage. During less frequent storm events, the flood elevation at Oasis pond is largely driven by the drainage area that is downstream of the County Road C crossing. The most pressing water concerns at Oasis Pond and downstream are not flood elevations during large storm events, but rather from high flow and velocity downstream of Oasis Pond for more frequent events such as the 2-year flood, which have resulted in problematic scouring and bank erosion.

The main benefit of extending storage capacity beyond Rule C is reducing sediment and nutrient delivery downstream. The additional storage and filtration capacity could potentially treat stormwater that is currently untreated and provide treatment during larger, less frequent rainfall events. However, sizing for water quality treatment for these larger events is not typically a design consideration due to the infrequency of the events and the substantial cost of managing larger flows. To reduce the cost of the additional storage capacity, the size of the additional storage capacity could be less than the maximum practical amount. This would result in an equivalent (roughly) reduction in effectiveness.

PRELIMINARY COST ESTIMATE

The costs to install an additional storage beyond Rule C was estimated for planning purposes. **Table 6** shows the opinion of probable costs for additional on-site storage.

Table 6 – Additional On-site Storage Preliminary Cost Estimate

Item	Unit	Unit Price	Quantity	Cost
EXCAVATION	CY	\$3	35,850	\$107,550
36-INCH RCP	LF	\$100	450	\$45,000
48-INCH RCP	LF	\$190	400	\$76,000
STORAGE CHAMBER UNITS	EACH	\$900	2,275	\$2,047,500
STORAGE CHAMBER END CAPS	EACH	\$1,000	90	\$90,000
WASHED ROCK	CY	\$66	26,748	\$1,765,368
			Construction Cost	\$4,131,418
			Contingency (25%)	\$1,032,855
			Total Cost	\$5,164,273

FINAL CONCLUSIONS

Based on hydraulic analysis, a 7-foot diameter concrete pipe can feasibly be constructed to replace the open channel ditch between County Road C and Terrace Drive. Doing so will provide multiple benefits to the landowners, the City, and the RCWD, including but not limited to reduction in maintenance of RCWD drainage systems and facilities, increases in usable and developable property, and incorporation of planned City recreational infrastructure. Please note, however, that a monetization of benefit and comparison to project cost has not yet been completed. We recommend the RCWD and City proceed with the next phase of project consideration, which would include the assigning of project benefit and cost, and development of project timelines.

Incorporating underground flood storage on the adjacent developing properties in excess of Rule C requirements provides limited benefit in reducing downstream flood elevations and flows for more frequent (2-year) events and for water quality treatment. Given the substantial cost of constructing this storage on these sites, (and considering that one of these sites is already nearing permit approval) the work does not appear to be economically viable and we do not recommend the RCWD complete any further consideration of partnership on stormwater storage at these sites.