



# **WINDMILL CREEK DRAINAGE BASIN EVALUATION OF CONSTRUCTION PHASING OF POND W-4**

Prepared for:

**SOUTHEAST METRO STORMWATER AUTHORITY**  
Englewood, Colorado

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# **WINDMILL CREEK DRAINAGE BASIN EVALUATION OF CONSTRUCTION PHASING OF POND W-4**

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## **1.0 INTRODUCTION**

Pond W-4 is a proposed stormwater detention facility to be located in the Windmill Creek drainage basin in Arapahoe County. It is a major component of a regional plan to provide detention of 100-year stormwater event peak flows from developed areas. Pond W-4 is proposed for stormwater detention only. Other facilities within the drainage basin serve the requirements for water quality capture volume (WQCV).

Ideally, stormwater detention regional facilities like Pond W-4 would be fully constructed prior to upstream development occurring. In fact, some regional facilities have been constructed in this manner. However, the construction of regional facilities in phases to address development as it occurs is not uncommon. Phased construction is currently done in the northeast Denver Metropolitan area.

### **1.1 Why Consider Phasing of Pond W-4?**

In 2005, a final design was performed with the intention of construction of the full volume needed in Pond W-4. The full required detention storage volume is 23.5 acre – feet (AF). The final design also included approximately 1,200 feet of the major channel section upstream of Pond W-4. In October, 2006, the engineer (WRC Engineering, Inc. [WRC]) estimated that the capital cost of the constructed facility would be \$1.45 million (not including engineering and other professional services fees). Funding for construction of this project has not been available, nor is it available at this time. However, there is an immediate need for stormwater detention in Pond W-4 due to existing conditions and current development plans.

Construction of an initial phase of Pond W-4 (Phase 1) has been proposed to provide temporary stormwater detention storage to address ongoing development plans. Construction of Phase 1 of Pond W-4 could be performed at lower costs when compared to the capital costs of constructing the full storage volume of 23.5 AF. It is anticipated

that lower Phase 1 costs could be immediately funded and result in providing stormwater detention volume earlier than a fully constructed project. In a phased approach, stormwater detention can be provided earlier for proposed development.

In the course of this study, a major factor that has emerged for considering construction phasing of a regional stormwater detention facility is whether or not it is acceptable to exceed the Master Plan 100-year stormwater event peak flow rate in downstream channels, especially when the Master Plan flows are less than the historic, predevelopment flows. This factor has been considered in this evaluation of construction phasing of Pond W-4 (however, the legal and policy aspects of it have not been addressed). To address this factor, two approaches were used in the development of the construction phasing scenarios presented in this report: 1) construct a Phase 1 detention storage volume to allow Master Plan flows to be exceeded but don't exceed existing calculated peak flows, and 2) construction a Phase 1 detention storage volume that results in meeting Master Plan peak flows.

## **1.2 Agreement and Purpose of Study**

Southeast Metro Stormwater Authority (SEMSWA) retained Wright Water Engineers, Inc. (WWE) (Agreement dated December 11, 2007) to evaluate construction of Phase 1 of Pond W-4. The purpose of the study was to investigate the possibility of a phased construction to allow some time (e.g., at least two years) before the full construction of Pond W-4 would be required. This approach was intended to provide temporary stormwater detention for near-term development and allow time for funding to be acquired for construction of the entire Pond W-4 facility.

WWE performed the following major tasks:

- Performed stormwater computer modeling to evaluate the detention requirements within the Windmill Creek basin.
- Prepared a rough grading plan for Phase 1 of Pond W-4.
- Performed hydraulic calculations for the Phase 1 pond outlet.

- Estimated additional detention storage requirements under two Phase 1 scenarios.
- Developed an opinion of probable capitals costs for two Phase 1 scenarios.

## **2.0 BACKGROUND**

The stormwater master plan for the Windmill Creek drainage basin is addressed in the 1994 *Design Report for Lone Tree, Windmill, Dove and Cottonwood Creeks Drainage and Water Quality Facilities* (Master Plan). This Master Plan has been approved by the Urban Drainage and Flood Control District (UDFCD), Arapahoe County, and Arapahoe County Water and Wastewater Authority (ACWWA). This Master Plan is the most recent, approved stormwater plan for the Windmill Creek basin. The basis for the stormwater detention facilities and major conveyance channels presented in the Master Plan are the result of a stormwater computer drainage model. WWE has used this stormwater model for design criteria and to review development submittals. In the original 1987 Master Plan, models were created for existing conditions and future (buildout) conditions. The future conditions models were used for sizing of master planned drainage facilities. The existing conditions models are routinely updated to reflect new development and new facilities and are now used as “current conditions” models to evaluate the need for new facilities. WWE has modified the future conditions model only by changing imperviousness of areas as they are developed (if they exceed values used in the original future conditions model). The future conditions model also was updated several years ago to reflect revised planning involving combining Ponds W-1 and W-2.

The stormwater computer drainage model is very similar to models used throughout the Metro Denver region and is “state of the practice” with regard to UDFCD. The results presented in this report are based on the stormwater model developed for the Windmill Creek basin.

### **2.1 Design and Construction of Regional Stormwater Facilities**

The major aspect of a regional stormwater detention master plan is that all of the stormwater components within a drainage basin work together on a basin-wide basis to limit downstream flows to allowable rates established in the Master Plan for the protection of public health, safety, and welfare. In the Master Plan for the Windmill

Creek basin, the upstream regional stormwater detention facilities are planned to “over detain” the 100-year stormwater event peak flows. This means that the Master Plan peak flows in the channel downstream of Pond W-4 are actually *less* than predevelopment (i.e., historical) peak flows so that the historic or allowable established peak flows can be met further downstream.

The design criteria that have been used for stormwater facilities that are downstream of Pond W-4 are established in the Master Plan. These criteria assume that all regional stormwater facilities are in place and that the basin is fully developed, as planned. Many of these facilities have already been constructed based on these criteria.

## **2.2 Status of Windmill Creek Stormwater Facilities**

There are many major regional stormwater facilities that have been constructed and exist in the Windmill Creek basin. These include Pond W-5, Pond W-6/W-7, and Pond W-8. A Phase 1 construction of Pond W-1/W-2 has been accomplished to provide 70 AF of an eventual 101 AF. There are also major channel segments that are in place.

The planned stormwater detention facilities that remain to be constructed are Pond W-4 and the next phase of Pond W-1/W-2. There is also the need to modify the outlet at the existing Pond W-5.

There are also several major channel segments that remain to be constructed. These are located, from upstream to downstream, as follows:

- Just upstream of Pond W-1/W-2.
- Between the Centennial Airport East-West Runway and the proposed location of Pond W-4.
- Downstream of the intersection of East Broncos Parkway and South Potomac Street to South Blackhawk Street.
- Just downstream from Arapahoe Road to Jordan Road.



## **2.3 Issues of Phasing Master Planned Projects**

The existing Master Plan only addresses the built-out conditions where all of the regional stormwater facilities work together on a basin-wide basis and the basin is fully developed. A phased plan for construction of the regional facilities was not addressed in the Master Plan. To WWE's knowledge, a phased construction plan has not been adopted nor is there an "official" position regarding phasing.

Since 2002, WWE has reported to ACWWA and Arapahoe County that additional stormwater detention is needed in the Windmill Creek basin. This is when, on behalf of ACWWA, WWE began reviewing stormwater site plans for new developments.

There are four ways to address the phased implementation of a regional stormwater detention plan. These are:

1. Construct the entire system of regional stormwater facilities prior to development occurring. This requires an enormous financial investment for facilities that may not be needed for some time (e.g., 10 to 20 years).
2. Construct individual regional stormwater detention facilities and/or conveyance channels as development occurs. Since downstream facilities are designed based on Master Plan peak flows, phased construction for over-detention is needed, not simply detention to meet historic peak flows.
3. Construct temporary onsite stormwater detention for each property as developed. This approach is counter to the economic advantages of regional detention since the developer needs to pay for both onsite detention and regional detention. In addition, the onsite detention should be designed to over-detain since downstream facilities are designed based on Master Plan peak flows.
4. Construct partial stormwater detention ponds recognizing that there will be downstream exceedances of the stormwater modeled peak flow conditions that may occur until the Master Plan facilities are constructed. This approach could have legal issues if the historic flows are exceeded and flooding risks if the Master Plan flows

are exceeded. Therefore, this approach requires that the downstream peak flow conditions and impacts be assessed for acceptability.

The evaluation of the phasing of Pond W-4 addresses these approaches, with the exception of the temporary onsite stormwater detention. This report also does not include assessments of peak flows that exceed the Master Plan flows and the potential impacts where facilities have already been constructed to Master Plan criteria.

### **3.0 EXISTING DEVELOPMENT CONDITIONS: COMPARISON WITH AND WITHOUT FULL CONSTRUCTION OF POND W-4**

WWE performed stormwater modeling of 100-year stormwater peak flow rates in Windmill Creek assuming existing development conditions. The existing stormwater detention facilities that were included in the Windmill Creek model were Pond W-5, Pond W-6/W-7, and Pond W-8. The stormwater model included a partial completion of Pond W-1/W-2 at approximately 70 AF. It is important to note that Pond W-1/W-2 will need to be fully constructed in the future to meet the Master Plan.

Initially, WWE performed stormwater model calculations for Windmill Creek under the following scenarios:

- Existing development conditions without any stormwater detention volume in Pond W-4.
- Existing development conditions with fully constructed Pond W-4.

These scenarios were initially evaluated to determine the extent of exceedances of the Master Plan peak flows and to compare peak flows with and without Pond W-4 at specific locations.

#### **3.1 Without Pond W-4**

The stormwater model results for 100-year stormwater peak flow rates in Windmill Creek for existing development conditions and without Pond W-4 are presented in Table 1.

**TABLE 1**  
**100-Year Stormwater Peak Flow Rates in Windmill Creek**  
**Under Existing Development Conditions and Without Pond W-4 (See Figure 1)**

<b>Location</b>	<b>Allowable Stormwater Flow Per Master Plan (cubic feet per second [cfs])</b>	<b>Stormwater Model Results (cfs)</b>
Pond W-4 Outflow	338	598
Downstream of Broncos Parkway and Potomac	391	598
Pond W-6/W-7 Outflow	901	1,055
Arapahoe Road	966	1,091
Pond W-8 Outflow	1,144	1,235

A graphical presentation of the results is also presented on Figure 1.

At every location, the 100-year stormwater peak flow exceeds the allowable Master Plan flow. WWE did not assess the local impacts of these exceedances, since this was not included in our scope of work. Results presented in Table 1 and Figure 1 show that additional stormwater detention for the 100-year storm event is needed in the upper Windmill Creek basin, even for **existing development conditions**.

Since 2002, WWE has reported this condition in comments on review of stormwater site plans for new developments to ACWWA and Arapahoe County.

### **3.2 Existing Conditions With Fully Constructed Pond W-4**

The results of the stormwater modeling under existing development conditions and assuming that Pond W-4 is constructed as currently designed (i.e., full volume) are addressed in Table 2 and shown schematically in Figure 2.

As shown in Table 2, **the construction of the full volume of Pond W-4 (as designed) will reduce the 100-year stormwater peak flow rate in Windmill Creek downstream of Pond W-4 to below Master Plan allowable 100-year peak flow rates.**

The construction of full Pond W-4 would accommodate additional development. However, future construction of the full Pond W-1/W-2 will be needed to allow development to occur to built-out conditions.

**TABLE 2**  
**100-Year Stormwater Peak Flow Rates in Windmill Creek**  
**Under Existing Conditions with Pond W-4 Constructed as Currently Designed<sup>1</sup>**  
**(See Figure 2)**

<b>Location</b>	<b>Allowable Stormwater Flow Per Master Plan (cfs)</b>	<b>Stormwater Model Results (cfs)</b>
Pond W-4 Outflow	338	288
Downstream of Broncos Parkway and Potomac	391	325
Pond W-6/W-7 Outflow	901	808
Arapahoe Road	966	881
Pond W-8 Outflow	1,144	1,046

<sup>1</sup> The current design needs adjustment to the outlet restriction to better utilize the design storage volume.

## **4.0 PHASING CONSTRUCTION OF POND W-4**

As presented in Section 2.0 of this report, there are several ways to approach planning of construction of regional stormwater detention facilities. For the phasing of Pond W-4, WWE has discussed the possible approaches with representatives of the various interests within the Windmill Creek basin. The possible approaches and issues have also been discussed at Board of Director meetings for both ACWWA and SEMSWA.

### **4.1 Development of Scenarios – Factors**

The major question regarding the construction phasing of Pond W-4 is: what should be the detention storage volume (in terms of AF) of Phase 1 of Pond W-4? The fully constructed, and master planned, stormwater detention volume of Pond W-4 is 23.5 AF.

There were several major factors that were considered in the development of the construction phasing scenarios for Pond W-4.

### **4.2 Factors**

#### ***4.2.1 Agency Approach for Acceptable Interim Downstream Stormwater Flows***

The stormwater detention volume that is constructed in Phase 1 of Pond W-4 will establish, by stormwater model calculation, the downstream peak stormwater flow for the interim conditions (until Pond W-4 is fully constructed). Current

development conditions exceed the Master Plan 100-year peak flows downstream of the location of proposed Pond W-4.

At the onset of this study, it became apparent that there are differences in the approach of the agencies that consider stormwater planning for future development. One of the differences that is a major factor in this study is whether or not it is acceptable to exceed the Master Plan peak flow rates in downstream channels. WWE has considered this factor in establishing the construction phasing scenarios of Pond W-4 that are presented in this report.

Two approaches were applied to define the phasing scenarios: 1) construct a phased detention storage volume to allow Master Plan flows to be exceeded but don't exceed existing calculated peak flows, and 2) construct a phased volume that results in meeting Master Plan 100-year peak flows.

This report addresses two scenarios that have been developed based on these two different approaches. The differences in downstream peak flow rates have been calculated and estimated capital costs have been determined.

The legal and policy aspects of these approaches are not addressed in this report.

#### ***4.2.2 Upstream Parcels to be Developed in the Near-Term***

Based on information available to WWE, the following parcels are planned to be developed in the Pond W-4 drainage subbasins. These parcels are located upstream of Pond W-4 and downstream of Pond W-1/W-2.

The parcels to be developed in the near-term are presented in Table 3.

**TABLE 3**  
**Parcels to be Developed in the Near-Term in**  
**Subbasins Draining Directly to Pond W-4**

<b>Parcel</b>	<b>Land Area (Acres)</b>	<b>Anticipated Impervious Area (Acres)</b>
Airport	27	21.6
Brown Brothers	7.7	6.2
Mirage	7.5	6
<b>TOTAL</b>	42.2	33.8

#### ***4.2.3 Volume of Earth Excavation***

This is a major factor in the development of scenarios since the volume and handling of the excavated earth from the Pond W-4 site will significantly impact capital costs. Greater excavation volume also results in a longer construction schedule.

Many other regional detention facilities have a natural depression since they usually are online facilities and earth has been eroded by historic stormwater flows. This is not the case at the Pond W-4 site. In fact, the topography on the Pond W-4 site rises at a significant slope on the south portion of the site. Therefore, Phase 1 construction is intended to avoid this area that will require significant excavation just to bring the site to level conditions.

#### ***4.2.4 Utility Relocation***

Currently, there are utilities on the site that will need to be relocated under a fully constructed Pond W-4. These utilities include an ACWWA wastewater interceptor (12-inch diameter) and an Xcel Energy underground power line. The relocation of these utilities were considered in the scenario development for Phase 1, since their relocation would result in greater cost and longer construction schedule.

### **4.3 Scenarios**

Based on discussions with the various interests within the Windmill Creek drainage basin and considering the factors above, WWE developed two scenarios for construction

phasing of Pond W-4. Although consideration was given to costs and schedule of construction, the major distinction between the two scenarios is the resultant stormwater model calculations of downstream 100-year peak flow rates. The scenarios are based on the stormwater detention volumes to meet the two described peak flow conditions.

#### ***4.3.1 Phase 1 Stormwater Detention Volume at 5 AF***

This scenario was developed to provide stormwater detention volume only for the anticipated, near-term, development as shown in Table 3. Downstream peak stormwater flows would not exceed calculated existing conditions; however, the Master Plan stormwater flows would still be exceeded (see next section).

This scenario represents the minimum detention storage volume that should be considered. This scenario would result in a comparatively lower excavated volume (13,000 to 15,000 cubic yards) and avoid relocation of the ACWWA wastewater interceptor and the underground power line.

#### ***4.3.2 Phase 1 Stormwater Detention Volume at 15 AF***

This scenario would capture the peak stormwater flows from the existing development and the near-term, exclusive development shown in Table 3, with the specific goal of meeting the Master Plan flows downstream of Pond W-4 under current conditions.

Excavation of approximately 28,000 cubic yards would be required to provide the stormwater detention volume. As a comparison, the fully constructed Pond W-4 will require approximately 120,000 cubic yards of excavation. The significant volume difference of excavation between this Phase 1 scenario and the fully constructed Pond W-4 is due to the topography on the south side of the site and that the fully constructed Pond W-4 includes approximately 1,700 feet of excavation of the stormwater channel upstream of Pond W-4.

The 15 AF scenario would require the relocation (i.e., reburial) of the existing power line. However, WWE has developed a grading plan for the 15 AF scenario

that will avoid the relocation of the existing wastewater interceptor, see Section 5.1.

#### **4.4 Stormwater Model Calculations**

This section presents the stormwater model calculations for the downstream 100-year peak flow conditions for each phasing scenario.

##### **4.4.1 Phase 1 at 5 AF**

Based on the stormwater model calculations, providing 5 AF of stormwater detention storage at Pond W-4 results in the 100-year peak flows that are shown in Table 4 for existing development conditions plus future development of the three parcels in Table 3. These 100-year peak flows are compared to “baseline conditions”, which represent the stormwater model 100-year peak flows for existing development conditions without any stormwater detention in Pond W-4. The stormwater model results in Table 4 indicate that 5 AF of detention storage is sufficient for the near-term development to maintain baseline conditions.

**TABLE 4**  
**100-Year Stormwater Peak Flow Rates in Windmill Creek**  
**Under Existing Conditions Without Pond W-4 (Baseline) and with Phase 1 at 5 AF**  
**(See Figure 3)**

<b>Location</b>	<b>Allowable Stormwater Flow Per Master Plan (cfs)</b>	<b>Baseline Conditions<sup>1</sup> (cfs)</b>	<b>Phase 1 at 5 AF<sup>2</sup> (cfs)</b>
Pond W-4 Outflow	338	598	502
Downstream of Broncos Parkway and Potomac	391	598	547
Pond W-6/W-7 Outflow	901	1,055	1,043
Arapahoe Road	966	1,091	1,069
Pond W-8 Outflow	1,144	1,235	1,207

<sup>1</sup> Existing conditions without any further development and without Pond W-4.

<sup>2</sup> Future development as shown in Table 3 and 5 AF of stormwater detention volume in Pond W-4.

##### **4.4.2 Phase 1 at 15 AF**

Based on the stormwater model calculations, providing 15 AF of stormwater detention storage at Pond W-4 results in the 100-year peak flows that are shown in Table 5 for existing development conditions plus future development of the three parcels in Table 3.



This table shows that a stormwater detention volume of 15 AF is sufficient to bring stormwater modeled 100-year peak flows to within the Master Plan requirements.

**TABLE 5**  
**100-Year Stormwater Peak Flow Rates in Windmill Creek**  
**Under Existing Conditions with Phase 1 at 15 AF (See Figure 4)**

Location	Allowable Stormwater Flow Per Master Plan (cfs)	Phase 1 at 15 AF <sup>1</sup> (cfs)
Pond W-4 Outflow	338	338
Downstream of Broncos Parkway and Potomac	391	376
Pond W-6/W-7 Outflow	901	900
Arapahoe Road	966	928
Pond W-8 Outflow	1,144	1,093

<sup>1</sup> Future development as shown in Table 3 and 15 AF of stormwater detention volume in Pond W-4.

## **5.0 PRELIMINARY DESIGN AND ESTIMATED CAPITAL COSTS**

The design components of both Phase 1 scenarios were established and refined to the extent that opinion of probable capital costs were developed.

### **5.1 Design Assumptions and Major Components**

The assumptions that were used to arrive at the major components of the design of Phase 1 are as follows:

- The design must result in attaining UDFCD maintenance eligibility requirements** – Although the Phase 1 construction of Pond W-4 is intended as a temporary facility, the design should address the possibility that this Phase 1 construction may be a longer-term facility. Therefore, the design should comply with UDFCD criteria with the goal that the Phase 1 facility be maintained under the UDFCD maintenance program. To be eligible for UDFCD maintenance requires several design features beyond excavation for stormwater detention volume. These design features include proper slope, riprap in critical areas, erosion protection, etc. The design must be reviewed and approved by UDFCD.
- Provide an outlet control to restrict 100-year peak flows** – There are three existing box culverts that convey stormwater under the intersection of East

Broncos Parkway and South Potomac Street. An outlet control structure at this location is needed in the Phase 1 construction.

3. **All excavated soil can be filled and compacted on the adjacent airport parcel** – In conversations with Mr. Robert Olislagers, Executive Director of Centennial Airport, the airport would accept the excess soil from the fully constructed Pond W-4 (approximately 120,000 cubic yards). Mr. Olislagers provided a site grading plan to show the placement of fill on the adjacent parcel. However, the airport is reluctant to accept the excess soil in phases.

A major assumption in this evaluation is that the airport will accept the smaller amount of excess soil from a Phase 1 project. If this assumption is not realized, the estimated capital costs would be significantly higher since another location for the excess soil would need to be identified and hauling the excess soil to a more distant location would be expensive. The estimated capital costs for export of excess soil is usually left to a contractor as “means and methods” in a bidding situation.

A site geotechnical investigation (i.e., soil borings and laboratory testing) has *not* been done for this site, even though final design drawings have been prepared. Therefore, another major assumption is that the soil that is excavated in Phase 1 from this site can be properly compacted for use on the airport parcel.

4. **Minimum earth cover over the ACWWA wastewater interceptor is 4 feet** – Neither scenario for Phase 1 construction includes relocating the existing wastewater interceptor. For the 15 AF scenario, it was assumed that a minimum of 4 feet earth cover is acceptable. In past projects, this minimum cover has been acceptable to ACWWA.
5. **A wetland permit can be obtained that shows temporary impacts** – A U.S. Army Corps of Engineers Nationwide Wetland Permit No. 43 was obtained for the construction of Pond W-4 in December, 2002. The permit was extended

though December, 2004. Since construction of Pond W-4 was not performed, the permit was allowed to expire. Therefore, a major assumption is that this Nationwide Permit can be renewed and the temporary impact to the existing wetland areas can be addressed by reseeding wetland plants.

A preliminary site grading plan and major aspects of the design of a 15 AF stormwater detention volume for Phase 1 construction is presented in Figure 5.

## **5.2 Opinion of Probable Capital Costs**

An opinion of probable capital costs (also referred to in this report as “estimated capital costs”) were developed for both Phase 1 scenarios: a 5 AF and a 15 AF stormwater detention volume.

For engineering projects, estimated capital costs are often prepared at several points during the project planning and design. The expected level of accuracy of costs is directly proportional to the level of engineering effort applied and the known details.

The estimated capital costs presented in this report are considered to be conceptual to preliminary design. For this level of engineering effort, the estimated capital costs may range from 25 percent higher than estimated to 15 percent less than estimated.

For the estimated capital costs presented in this report, WWE obtained unit cost information from several sources including two local contractors, UDFCD bid tabs program, previous WWE experience, etc.

A summary of estimated capital costs for both scenarios for Phase 1 construction are presented in Table 6. As previously discussed, the range of estimated capital costs represents the difference of placing the earth fill at the adjacent airport parcel or at another location determined by a contractor. More detailed estimated capital costs are presented in Appendix A.

**TABLE 6**  
**Summary of Estimated Capital Costs (2007 Dollars)**  
**Phase 1 Construction of Pond W-4**

<b>Scenario</b>	<b>Estimated Capital Costs<sup>1</sup></b>
5 AF	\$251,000 To \$371,000
15 AF	\$310,000 To \$567,000

<sup>1</sup> Range of estimated capital costs depending on location of fill: airport parcel or export to location determined by a contractor.

## **6.0 CONCLUSIONS**

1. A Phase 1 construction of Pond W-4 is possible, especially considering that funding is not available for the construction of the full stormwater detention volume in Pond W-4 (23.5 AF).
2. Based on stormwater model calculations for the 100-year event peak flows, approximately 12 AF of detention storage is needed in Pond W-4 *under existing conditions* to meet the Master Plan peak flow rates that were developed for *built-out conditions*. In other words, 12 AF of storage is needed at Pond W-4 to be in compliance with the Master Plan, just for existing development.
3. The construction of the full volume of Pond W-4 (as designed at 23.5 AF) will reduce the 100-year stormwater peak flow rate for existing conditions in Windmill Creek downstream of Pond W-4 to below Master Plan allowable 100-year peak flow rates.
4. Construction of Phase 1 of Pond W-4 must have at least 15 AF of detention storage volume to meet downstream Master Plan flows under current existing conditions and to allow a minimum of near-term development.
5. The construction of a first phase Pond W-4 with a detention storage volume at a minimum of 5 AF would address only the increase stormwater flows from three additional parcels upstream of Pond W-4. The 5 AF of detention storage volume would only serve to meet existing peak flow conditions downstream. These existing conditions 100-year peak flow rates are considerably higher than allowable rates in the Master Plan.

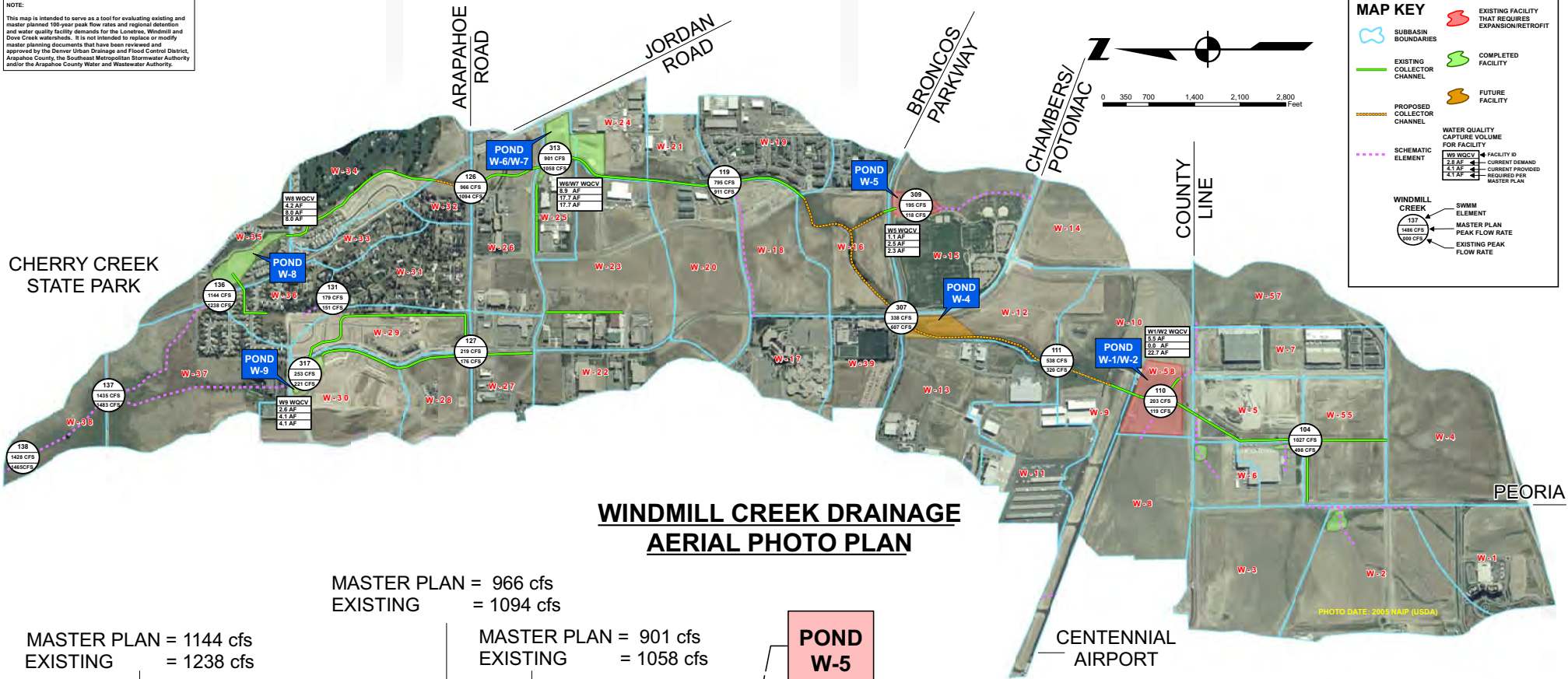
6. If it is determined that it is acceptable to construct a Phase 1 storage volume that results in further exceedances of the Master Plan flows, then an engineering determination should be made as to the impacts of the higher flow rates to facilities located downstream of Pond W-4.
7. A range of opinion of probable capital costs has been developed for each Phase 1 scenario as follows: 5 AF = \$251,000 to \$371,000 and 15 AF = \$310,000 to \$567,000. The range of costs represent the difference of earth fill placement on the adjacent airport parcel compared to exporting.

The estimated capital costs were developed using the various assumptions presented in this report. Under the 5 AF scenario, one of the major costs that are not included are for the engineering assessment of the downstream flow impacts of exceeding Master Plan flow rates.

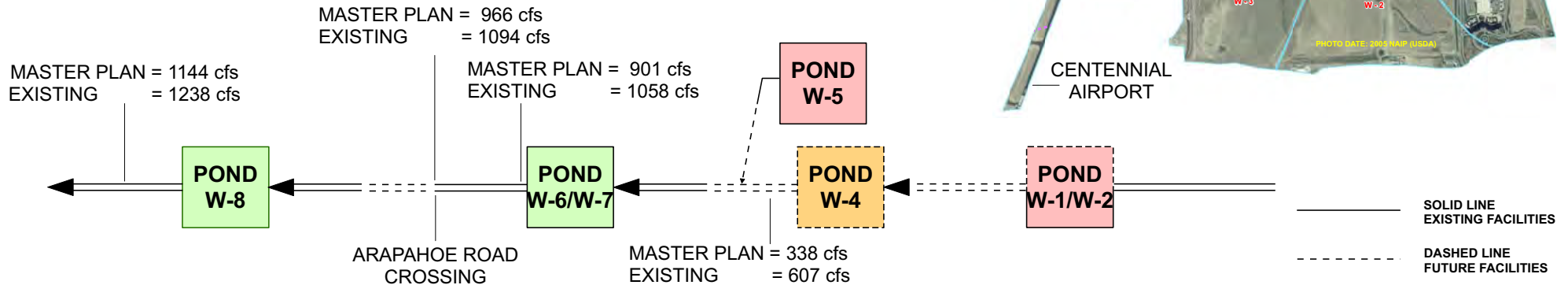
Z:\Project Files\07\071-136\071-136.010\Deliverables\Pond W-4 Report.doc

# FIGURES

**NOTE:**  
This map is intended to serve as a tool for evaluating existing and master planned 100-year peak flow rates and regional detention and water quality facility demands for the Lovelace, Windmill and Dove Creek watersheds. It is not intended to replace or modify master planning documents that have been reviewed and approved by the Denver Urban Drainage and Flood Control District, Arapahoe County, the Southeast Metropolitan Stormwater Authority and/or the Arapahoe County Water and Wastewater Authority.



## WINDMILL CREEK DRAINAGE AERIAL PHOTO PLAN

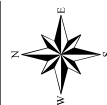


## SCHEMATIC PLAN - MODELED PEAK FLOW (100 YEAR) CONDITIONS

**WWE**

WRIGHT WATER ENGINEERS, INC.  
2490 W 26TH AVE. 100A  
DENVER, CO. 80211  
(303) 480-1700

**Southeast Metro  
Stormwater  
Authority**



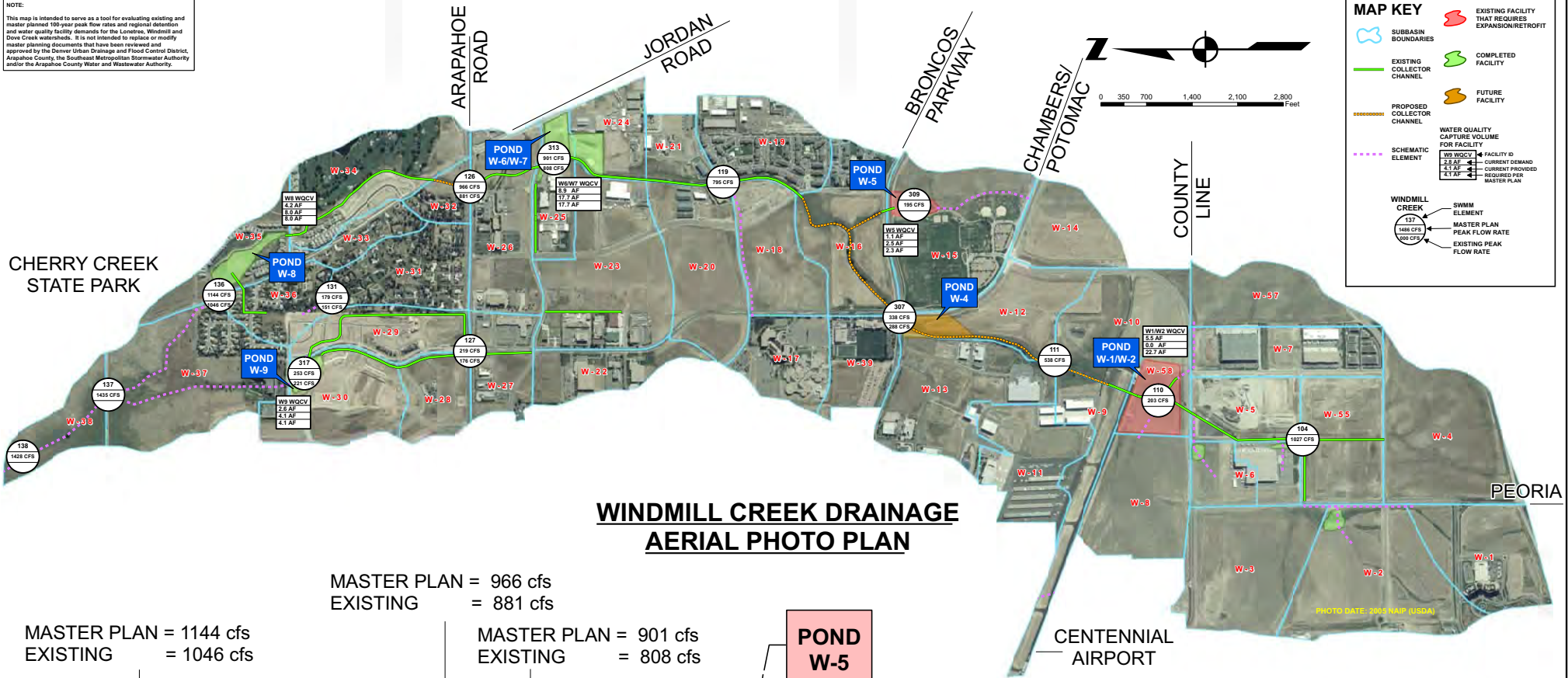
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DATE: JANUARY 15, 2008

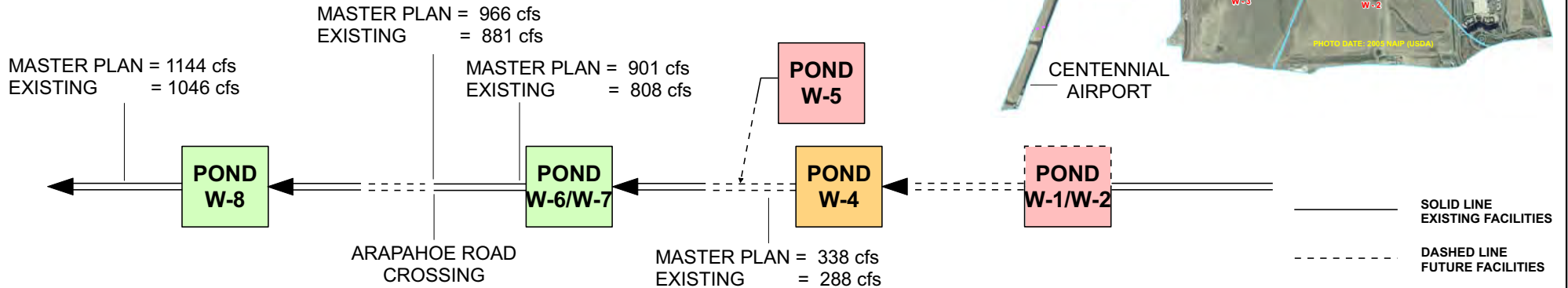
**100-YEAR STORMWATER PEAK FLOW RATES IN WINDMILL CREEK  
UNDER EXISTING CONDITIONS WITHOUT POND W-4  
(TABLE 1)**

**FIGURE  
1**

**NOTE:**  
This map is intended to serve as a tool for evaluating existing and master planned 100-year peak flow rates and regional detention and water quality facility demands for the Lovelace, Windmill and Dove Creek watersheds. It is not intended to replace or modify master planning documents that have been reviewed and approved by the Denver Urban Drainage and Flood Control District, Arapahoe County, the Southeast Metropolitan Stormwater Authority and/or the Arapahoe County Water and Wastewater Authority.



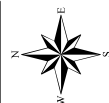
## WINDMILL CREEK DRAINAGE AERIAL PHOTO PLAN



## SCHEMATIC PLAN - MODELED PEAK FLOW (100 YEAR) CONDITIONS



WRIGHT WATER ENGINEERS, INC.  
2490 W 26TH AVE 100A  
DENVER, CO. 80211  
(303) 480-1700



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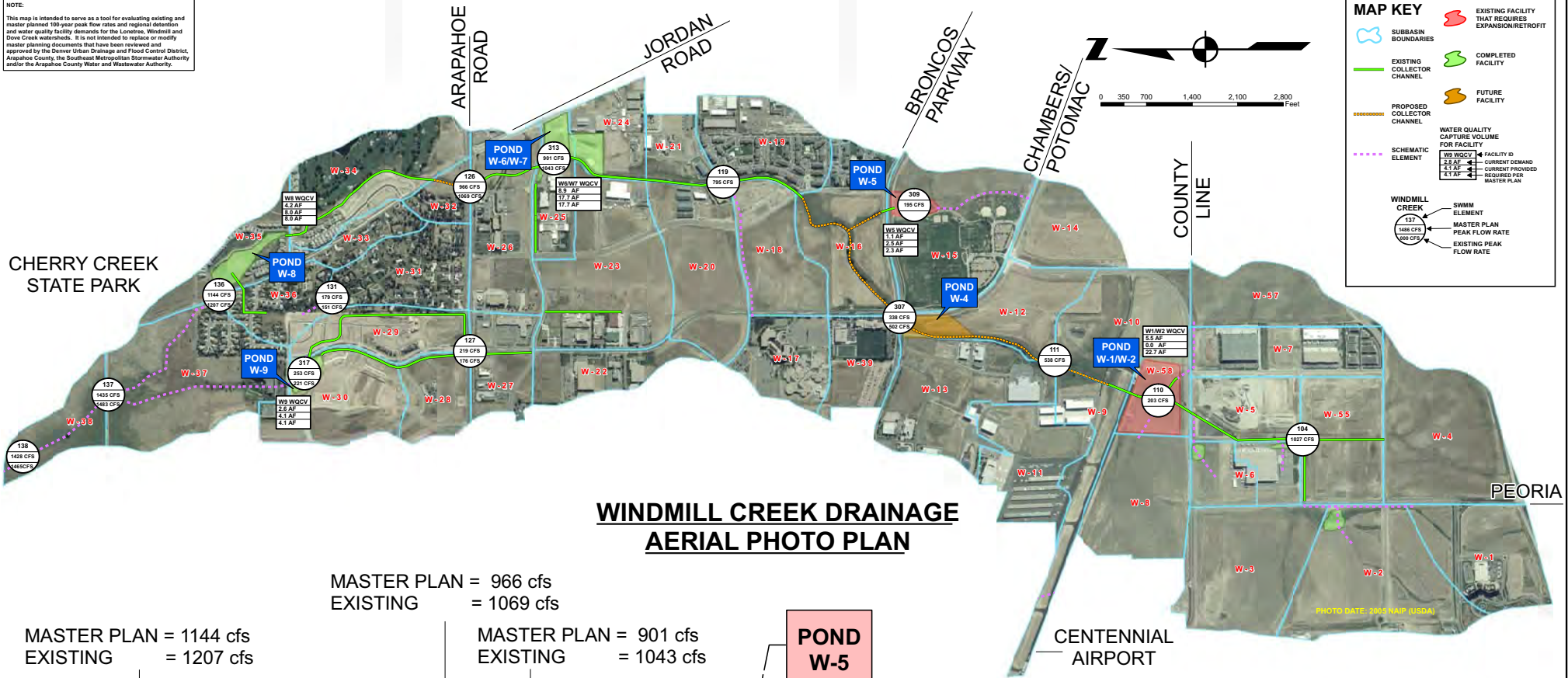
DATE: JANUARY 15, 2008

**100-YEAR STORMWATER PEAK FLOW RATES IN WINDMILL CREEK  
UNDER EXISTING CONDITIONS WITH POND W-4  
CONSTRUCTED AS CURRENTLY DESIGNED (TABLE 2)**

**FIGURE  
2**



**NOTE:**  
This map is intended to serve as a tool for evaluating existing and master planned 100-year peak flow rates and regional detention and water quality facility demands for the Loretto, Windmill and Dove Creek watersheds. It is not intended to replace or modify master planning documents that have been reviewed and approved by the Denver Urban Drainage and Flood Control District, Arapahoe County, the Southeast Metropolitan Stormwater Authority and/or the Arapahoe County Water and Wastewater Authority.

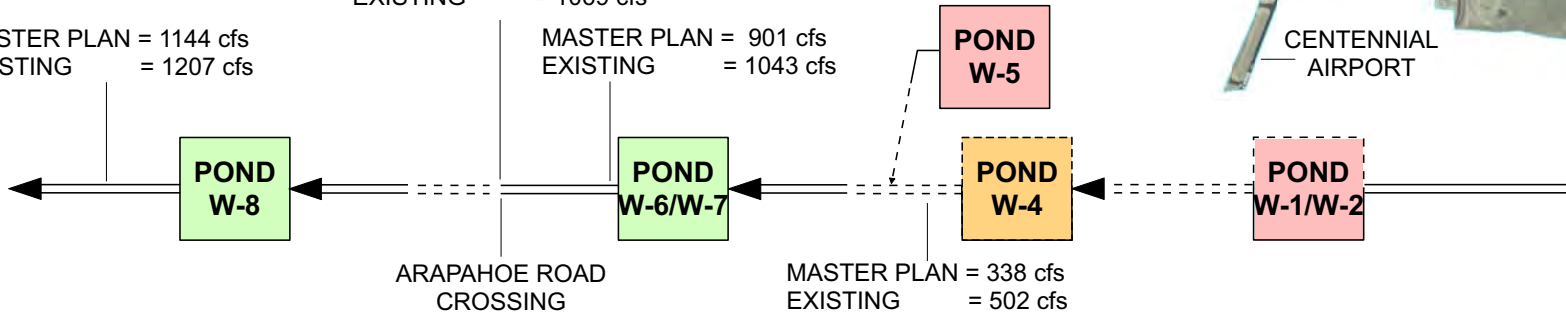


MASTER PLAN = 1144 cfs  
EXISTING = 1207 cfs

MASTER PLAN = 966 cfs  
EXISTING = 1069 cfs

MASTER PLAN = 901 cfs  
EXISTING = 1043 cfs

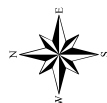
MASTER PLAN = 338 cfs  
EXISTING = 502 cfs



017508 GIS; 2-Project Files\07071-136\071-136.010\CAD-GIS\GISFIGURE\_3.mxd

**WWE**  
WRIGHT WATER ENGINEERS, INC.  
2490 W 26TH AVE, 100A  
DENVER, CO, 80211  
(303) 480-1700

**Southeast Metro Stormwater Authority**



0 350 700 1,400 2,100 2,800 Feet

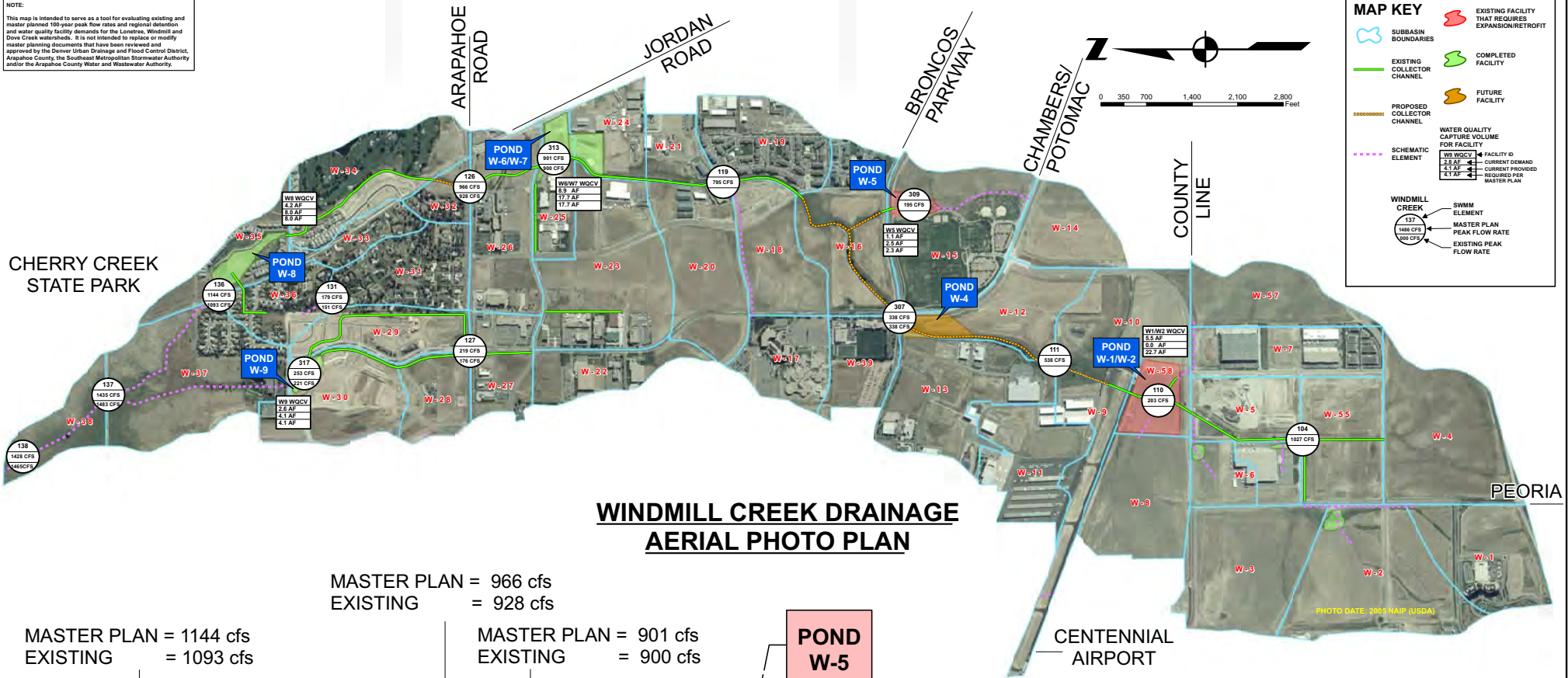
DATE: JANUARY 15, 2008

**100-YEAR STORMWATER PEAK FLOW RATES IN WINDMILL CREEK UNDER EXISTING CONDITIONS WITHOUT POND W-4 AND WITH PHASE 1 AT 5 AC-FT (TABLE 4)**

NOTE: Existing Development Conditions Plus Three Additional Future Parcels Not To Exceed Existing Peak Flows

**FIGURE 3**

**NOTE:**  
This map is intended to serve as a tool for evaluating existing and master planned 100-year peak flow rates and regional detention and water quality facility demands for the Lovelace, Windmill and Dove Creek watersheds. It is not intended to replace or modify master planning documents that have been reviewed and approved by the Denver Urban Drainage and Flood Control District, Arapahoe County, the Southeast Metropolitan Stormwater Authority and/or the Arapahoe County Water and Wastewater Authority.



MASTER PLAN = 1144 cfs  
EXISTING = 1093 cfs

MASTER PLAN = 966 cfs  
EXISTING = 928 cfs

MASTER PLAN = 901 cfs  
EXISTING = 900 cfs

**POND W-5**

**POND W-4**

**POND W-1/W-2**

**POND W-8**

**POND W-6/W-7**

ARAPAHOE ROAD CROSSING

MASTER PLAN = 338 cfs  
EXISTING = 338 cfs

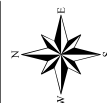
SOLID LINE  
EXISTING FACILITIES  
DASHED LINE  
FUTURE FACILITIES

### SCHEMATIC PLAN - MODELED PEAK FLOW (100 YEAR) CONDITIONS

**WWE**

WRIGHT WATER ENGINEERS, INC.  
2490 W 26TH AVE, 100A  
DENVER, CO, 80211  
(303) 480-1700

**Southeast Metro Stormwater Authority**



0 350 700 1,400 2,100 2,800 Feet

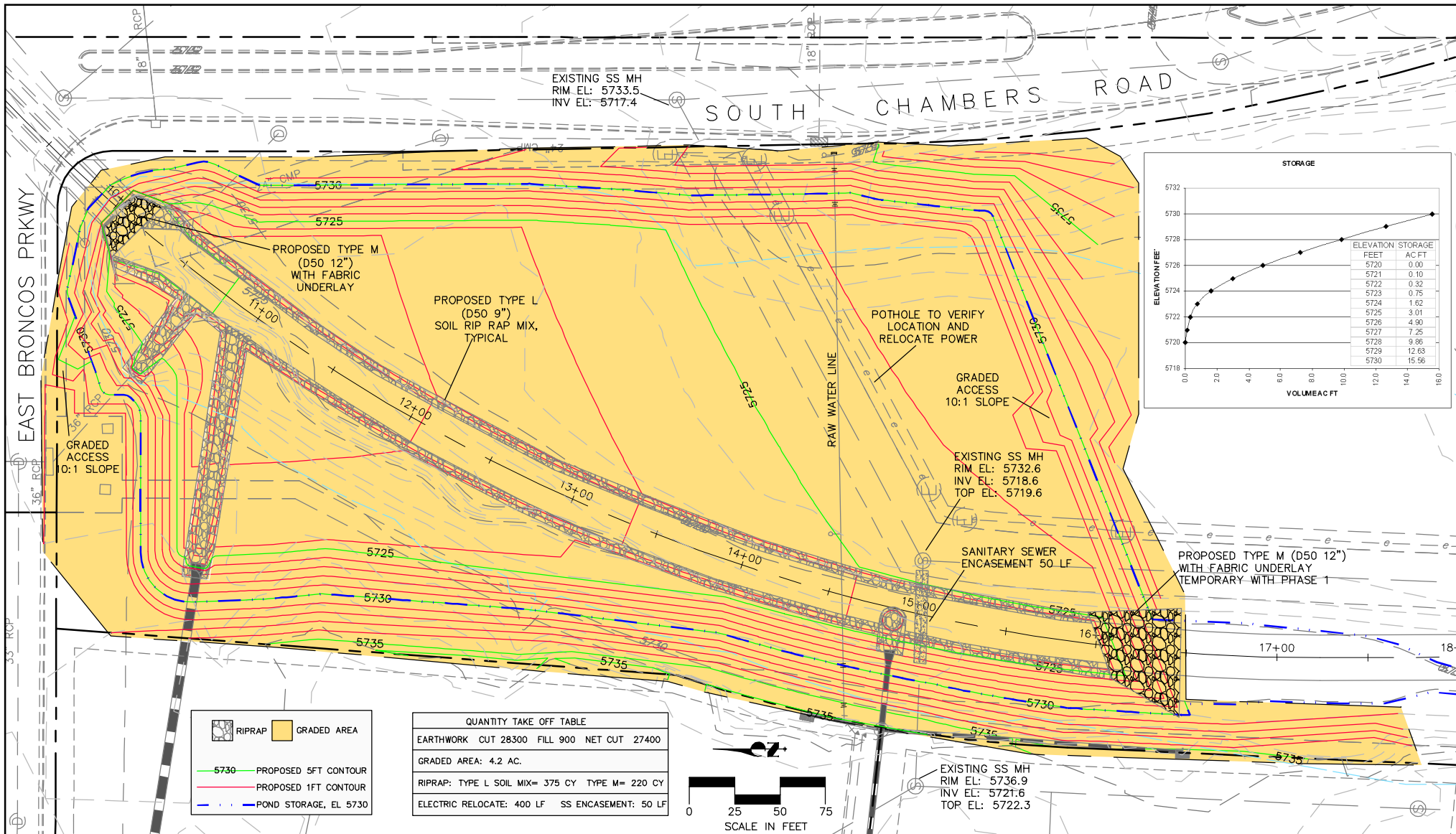
DATE: JANUARY 15, 2008

### 100-YEAR STORMWATER PEAK FLOW RATES IN WINDMILL CREEK UNDER EXISTING CONDITIONS WITH PHASE 1 AT 15 AC-FT (TABLE 5)

NOTE: Existing Conditions Plus Three Additional Future Parcels To Meet Master Plan Peak Flows

**FIGURE 4**





# **APPENDIX**

# **APPENDIX A**

## **Opinion of Probable Capital Costs**

# Wright Water Engineers, Inc.

Client:	SEMSWA
Project:	POND W-4

## OPINION OF PROBABLE CAPITAL COSTS DETENTION VOLUME 5 AC - FT

Project No: 071-136.010
Sheet 1 of 1
By: WFL Ckd: CMC
Date: 1/08/08 Date: 1/10/08

DESCRIPTION	COMMENTS/REFERENCES	QTY.	UNIT MEAS.	FILL AT AIRPORT PARCEL		FILL EXPORT TO CONTRACTOR LOCATION	
				UNIT COST	TOTAL COST	UNIT COST	TOTAL COST
Mobilization / Demobilization / Permits / Cleanup		1	LS	\$25,000	\$25,000	\$25,000	\$25,000
Excavation and Disposal	Fill at Airport Parcel (\$2/cy) or export (\$10/cy)	13,000	CY	\$2.00	\$26,000	\$10.00	\$130,000
Compacted Fill Onsite		900	CY	\$2.50	\$2,000	\$2.50	\$2,000
Topsoil Stripping and Stock Pile	3 acres at 8 inches deep	3,200	CY	\$3.00	\$10,000	\$3.00	\$10,000
Water Control (Dewatering & Storm)		1	LS	\$15,000	\$15,000	\$15,000	\$15,000
Riprap Along Channel & Run Downs D <sub>50</sub> = 9 inch Type L Soil Mix		300	CY	\$75	\$23,000	\$75	\$23,000
Channel Drop Structure - Temporary D <sub>50</sub> = 12 inch	Figure 5	220	CY	\$75	\$17,000	\$75	\$17,000
Filter Fabric		2,000	SF	\$2.00	\$4,000	\$2.00	\$4,000
Tailwater Basins	1 structure	1	LS	\$3,000	\$3,000	\$3,000	\$3,000
Outlet Structure							
Concrete Apron	retrofit onto existing RCBC	10	CY	\$1,000	\$10,000	\$1,000	\$10,000
Weir Plate		2,000	LBS	\$10	\$20,000	\$10	\$20,000
Trash Rack	35x10 sloping, attached to existing walls	1	LS	\$10,000	\$10,000	\$10,000	\$10,000
Erosion Control		1	LS	\$5,000	\$5,000	\$5,000	\$5,000
Revegetation (seed and straw crimp)		3	ac	\$3,000	\$9,000	\$3,000	\$9,000
Wetland Mitigation (seeded)		500	sf	\$3.00	\$2,000	\$3.00	\$2,000
Subtotal					\$181,000		\$285,000
Contingency (15%)					\$27,000		\$43,000
Subtotal for Construction					\$208,000		\$328,000
Engineering for Design of Phase 1					\$19,000		\$19,000
Engineering for Assessing Downstream Flow Impacts	This could be a significant cost to evaluate properly. Not included at this time.				Not Included		Not Included
Site Geotechnical Investigation & Testing					\$5,000		\$5,000
Additional Surveying					\$3,000		\$3,000
County Permits (Public Improvements & Floodplain)					\$3,000		\$3,000
Wetland 404 Permitting					\$5,000		\$5,000
Services During Bidding & Construction					\$8,000		\$8,000
Subtotal for Professional Services					\$43,000		\$43,000
<b>TOTAL</b>					<b>\$251,000</b>		<b>\$371,000</b>

# Wright Water Engineers, Inc.

Client:	SEMSWA
Project:	POND W-4

## OPINION OF PROBABLE CAPITAL COSTS DETENTION VOLUME 15 AC - FT

Project No: 071-136.010
Sheet 1 of 1
By: WFL Ckd: CMC
Date: 1/08/08 Date: 1/10/08

DESCRIPTION	COMMENTS/REFERENCES	QTY.	UNIT MEAS.	FILL AT AIRPORT PARCEL		FILL EXPORT TO CONTRACTOR LOCATION	
				UNIT COST	TOTAL COST	UNIT COST	TOTAL COST
Mobilization / Demobilization / Permits / Cleanup		1	LS	\$25,000	\$25,000	\$25,000	\$25,000
Excavation and Disposal	Figure 5	28,000	CY	\$2.00	\$56,000	\$10.00	\$280,000
	Fill at Airport Parcel (\$2/cy) or export (\$10/cy)						
Compacted Fill Onsite	Figure 5	900	CY	\$2.50	\$2,000	\$2.50	\$2,000
Topsoil Strip/Stockpile/Replace	4.2 acres at 8 inches deep	4,500	CY	\$3.00	\$14,000	\$3.00	\$14,000
Water Control (Dewatering & Storm)		1	LS	\$15,000	\$15,000	\$15,000	\$15,000
Riprap Along Channel & Run Downs							
D <sub>50</sub> = 9 inch Type L Soil Mix	Figure 5	375	CY	\$75	\$28,000	\$75	\$28,000
Channel Drop Structure - Temporary							
D <sub>50</sub> = 12 inch	Figure 5	220	CY	\$75	\$17,000	\$75	\$17,000
Filter Fabric		2,000	SF	\$2.00	\$4,000	\$2.00	\$4,000
Tailwater Basins	1 structure, 20' dia shaped riprap	1	LS	\$3,000	\$3,000	\$3,000	\$3,000
Outlet Structure							
Concrete Apron	retrofit onto existing RCBC	10	CY	\$1,000	\$10,000	\$1,000	\$10,000
Weir Plate		2,000	LBS	\$10	\$20,000	\$10	\$20,000
Trash Rack	35x10 sloping, attached to existing walls	1	LS	\$10,000	\$10,000	\$10,000	\$10,000
Relocate Power	Figure 5	400	FT	\$15	\$6,000	\$15	\$6,000
Wastewater Pipeline Encasement	Only under channel area needed.	50	FT	\$50	\$3,000	\$50	\$3,000
Erosion Control		1	LS	\$5,000	\$5,000	\$5,000	\$5,000
Revegetation (seed and straw crimp)		4	ac	\$3,000	\$12,000	\$3,000	\$12,000
Wetland Mitigation (seeded)		500	sf	\$3.00	\$2,000	\$3.00	\$2,000
Subtotal					\$232,000		\$456,000
Contingency (15%)					\$35,000		\$68,000
Subtotal for Construction					\$267,000		\$524,000
Engineering for Design of Phase 1					\$19,000		\$19,000
Site Geotechnical Investigation & testing					\$5,000		\$5,000
Additional Surveying					\$3,000		\$3,000
County Permits (Public Improve-ments & Floodplain)					\$3,000		\$3,000
Wetland 404 Permitting					\$5,000		\$5,000
Services During Bidding & Construction					\$8,000		\$8,000
Subtotal for Professional Services					\$43,000		\$43,000
<b>TOTAL</b>					<b>\$310,000</b>		<b>\$567,000</b>



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[www.wrightwater.com](http://www.wrightwater.com)

# WWE

Wright Water Engineers, Inc.