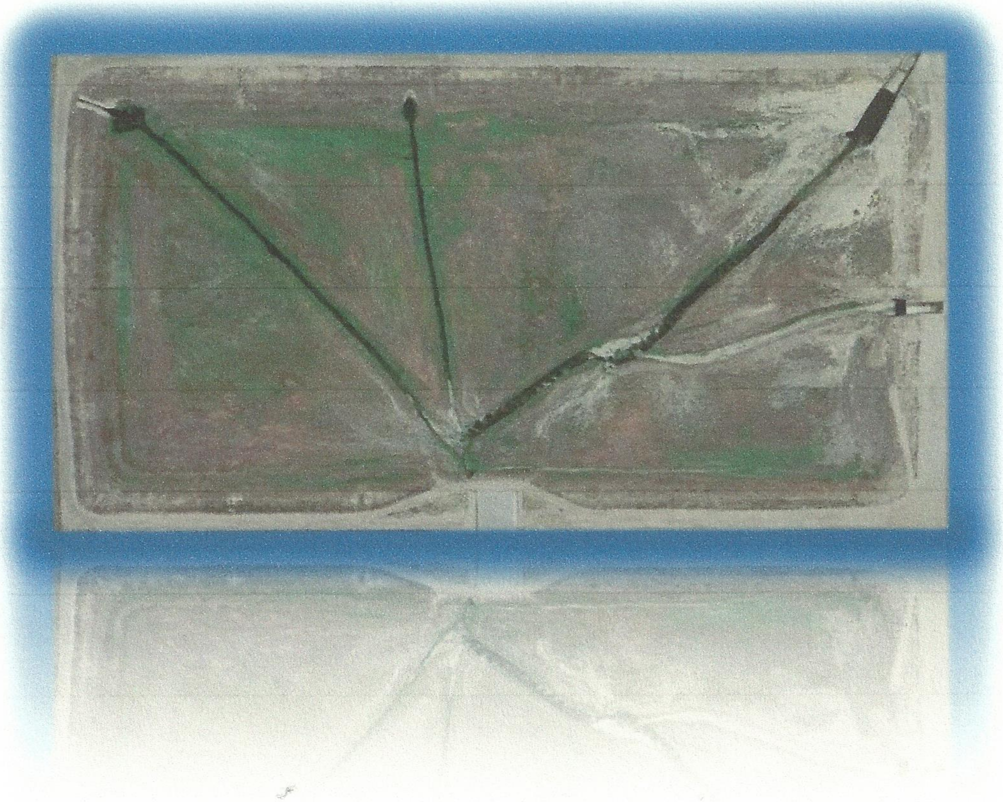
Wineville Basin
Proof of Concept Project
Final Report



Inland Empire Utilities Agency
A MUNICIPAL WATER DISTRICT

CHINO BASIN WATERMASTER

Chino Basin Watermaster — Partners in Basin Management

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Contents

Executive Summary

The Inland Empire Utilities Agency (IEUA) and the Chino Basin Watermaster (CBWM) have identified Wineville Basin as one of many possible locations to increase artificial groundwater recharge.

In order to assess the potential magnitude of artificial recharge at Wineville Basin (Basin), a Proof of Concept Project (PoC) was developed. The primary objective of the PoC was to develop and implement a short-term testing program to quantify potential infiltration rates in the Basin. In the fall of 2012 preliminary design of the PoC began. Preliminary design included the review of data from previous subsurface investigations and a more extensive investigation of the near-surface sediments in the Basin. Information from preliminary design was then used to design the PoC test program.

The final concept for the PoC Project was to excavate six separate “test cells” (approximately 0.5 acres in size) in the bottom of the Basin, supply each of the cells with water via a temporary pipeline and measure infiltration rates over a period of time. The horizontal and vertical locations of each of the test cells was designed to provide information corresponding to the variability of the sediments within the Basin and how that variation is likely to affect infiltration rates.

Construction was completed in September of 2013 and infiltration rate testing occurred in October and November of 2013. Measured infiltration rates ranged between 0.1 to 1.3 feet per day (ft/day), with the most likely sustainable infiltration rate being approximately 0.24 ft/day.

If Basin modifications occur and full scale artificial groundwater recharge operations commence, several factors will affect the actual long-term infiltration rates. Infiltration rates will fluctuate with source water availability, water quality, basin cleaning intervals and subsurface groundwater mounding. The actual infiltration rates may be slightly lower or higher than the 0.24 ft/day estimate and should be expected to vary from year to year as conditions change.

Two likely scenarios were developed to help quantify the potential volume of additional storm and supplemental water that could be recharged into the groundwater basin annually. Supplemental water includes both recycled water and imported water. Based on PoC test results, the potential new stormwater capture and recharge ranges from 820 to 2,080 acre-feet per year (ac-ft/yr). The potential new supplemental water recharge ranges from 940 to 1,750 ac-ft/yr (Table 1). These recharge projections assume minor basin grading, embankment reconstruction, the construction of flow control outlet structures and construction of supplemental water turnouts.

Table 1: Projected Basin Performance Summary

	Infiltration Rate	New Annual Stormwater Recharge	New Annual Supplemental Water Recharge	Total New Annual Recharge
Scenario #1 (conservative)	0.13 ft/day	820 ac-ft/yr	940 ac-ft/yr	1,760 ac-ft/yr
Scenario #2 (likely)	0.24 ft/day	2,080 ac-ft/yr	1,750 ac-ft/yr	3,830 ac-ft/yr

Project Description

Background Information

IEUA and the CBWM work jointly with the Chino Basin Water Conservation District (CBWCD) and the San Bernardino County Flood Control District (SBCFCD) to improve local water supply reliability and water quality throughout the Chino Groundwater Basin.

The Groundwater Recharge Program (GWR) includes the artificial recharge of stormwater and supplemental water (recycled and imported water). The recharge system consists of a network of pipelines, channels and basins that convey stormwater, imported water and recycled water to 16 recharge sites. These recharge sites are located throughout the 245 square mile IEUA service area and are designed to store the stormwater and supplemental water so that it can infiltrate into the subsurface and replenish the groundwater basin. IEUA currently recharges approximately 14,000 acre-feet of imported water; approximately 11,000 acre-feet of stormwater; and 7,000 to 12,000 acre-feet of recycled water annually.

In an effort to increase stormwater and supplemental groundwater recharge, IEUA is exploring opportunities to expand its artificial groundwater recharge capabilities in the Chino Groundwater Basin. A variety of options exist to enhance groundwater recharge capacity; the two primary approaches are to increase the efficiency of existing basins, or add new basins to the system. The Wineville Flood Control Basin was selected as one potential new location for IEUA to increase stormwater and supplemental groundwater recharge operations.

Due to the configuration of the Basin's inlets and outlets, the Basin acts as a flow-through Basin providing no long-term detention of flows. Due to this configuration, only a minimal amount of incidental stormwater recharge occurs annually. At this time, no facilities exist to directly deliver supplemental water to the Basin.

Incidental stormwater recharge occurs in Wineville Basin during the short periods of time between rain events and when the Basin drains to Riverside Basin. Currently, no artificial groundwater recharge of supplemental water is done at the Basin. Physical modifications to the Basin, along with operational modifications, would provide the ability to greatly increase stormwater recharge and create a new opportunity for supplemental water recharge at the Basin.

Several modifications/improvements would be required to the Wineville Basin in order to increase the artificial groundwater recharge potential of the Basin. Prior to the implementation of a capital improvement project, it was considered prudent to test and quantify the Basin's recharge potential to the extent practicable.

Project Objective

The Wineville Basin Proof of Concept Project was developed to provide information and data to determine the likely benefit if the Basin were improved to facilitate artificial groundwater recharge. The PoC Project was also used to identify conditions that may limit Basin infiltration rates, and explore opportunities to minimize or overcome those limitations.

The primary objective of the PoC was to measure Basin infiltration rates and use those rates to estimate the likely annual recharge capacity of the Basin in the event improvements are constructed. In order to quickly and cost effectively assess the potential of the Basin, a short-term, medium scale infiltration rate testing project was designed and implemented.

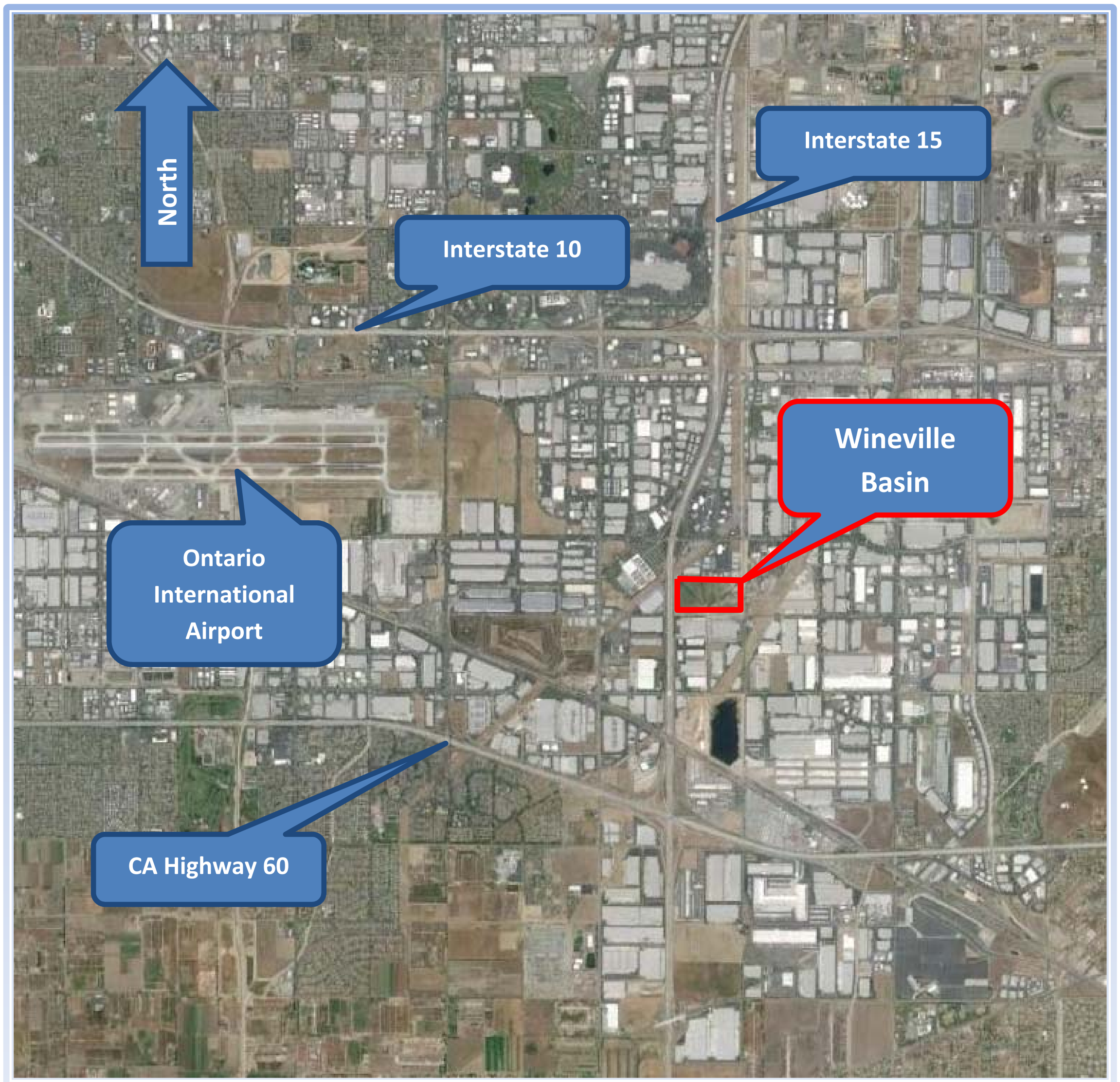
Project Area

Wineville Basin is located in San Bernardino County directly east of the Interstate 15 Freeway, approximately 1.3 miles north of the CA 60 Freeway and 1.6 miles south of the Interstate 10 Freeway in the City of Ontario (Figure 1). The Basin footprint is rectangular in shape and measures approximately 2,200 feet east to west and 1,200 feet north to south, equating to approximately 60 acres. The Basin was constructed in the early 1970's and is owned and operated by the San Bernardino County Flood Control District as a flood control basin. The approximate latitude and longitude of the center of the Basin is 34°02'33.00" N, 117°32'45.00" W. Basin elevations range from approximately 860' (NAVD 88) at the outlet of the Basin, up to elevation 890' (NAVD 88) at the top of the Basin.

Wineville Basin is bordered to the west by the Interstate 15 Freeway, bordered to the north by commercial businesses, bordered to the east by utilities/open space and bordered to the south by industrial businesses. The storage volume of the Basin lies below natural grade and has a gravel access road around its perimeter at the top of slope. Primary access to the Basin is at its southeast corner, at the intersection of South

Wineville Avenue and East Francis Street. A chain link fence extends around the perimeter of the Basin, along with a concrete block wall along the northern edge of the Basin.

Figure 1: Project Area Map

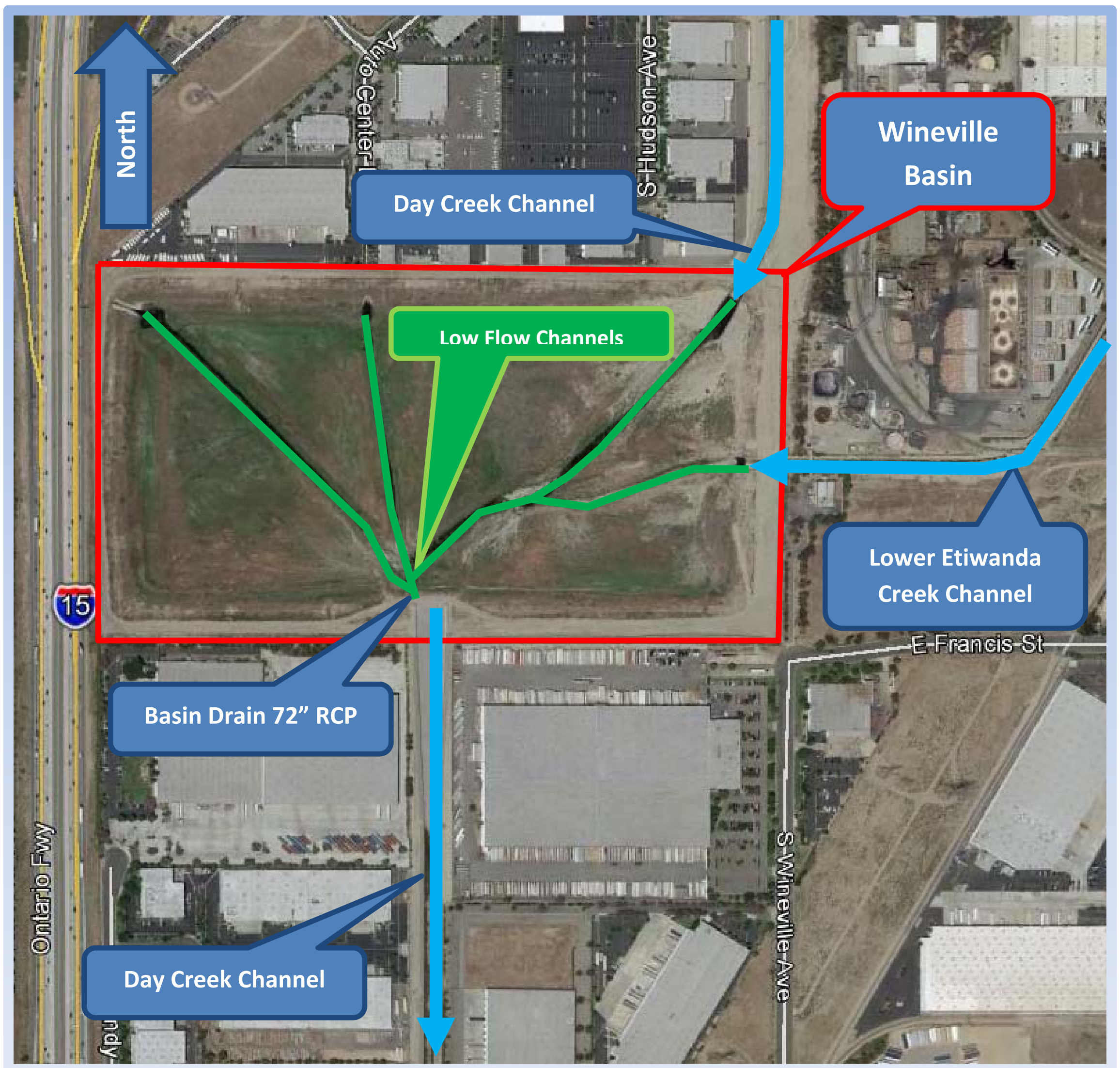


Basin Description

Wineville Basin is approximately 60 acres in size and has an average depth of approximately 25 feet. The overall volume of the Basin is approximately 1,200 acre-feet. A gravel maintenance road, with an average width of 60 feet, provides access to the perimeter of the Basin. The Basin side slopes average 3 feet horizontal to 1 foot of vertical distance (3:1). The bottom of the Basin generally slopes from north to south, with four excavated low-flow drainages channels maintained by SBCFCD to allow the Basin to drain, manage vector control issues and control nuisance flows through the Basin (Figure 2).

Wineville Basin controls flow from two large flood control channels and several smaller storm drains in the immediate vicinity of the Basin. The two largest tributaries to the Basin are Day Creek Channel and Lower Etiwanda Creek Channel. The bottom of Wineville Basin generally slopes from north to south, delivering flows to a 72" diameter reinforced concrete pipe (RCP) drain located at the invert of the Basin (elevation 861.2 NAVD 88). The Basin drain pipe is currently un-gated, which allows the Basin to empty after each storm event. Storm events that produce inflows, which exceed the capacity of the Basin drain pipe, cause an increase in the water elevation in the Basin until elevation 871.2, at which point, flow exits the Basin and continues south in Day Creek Channel for approximately 0.65 miles, until reaching Riverside Basin in Riverside County, CA.

Figure 2: Basin Map



The north-east quarter of Basin bottom is 1 to 3 feet higher than the rest of the Basin, this is due to sediment deposition from Day Creek Channel and Lower Etiwanda Creek

Channel. Sediments deposited in this area generally consist of fine to coarse grained sands, intermixed with smaller amounts of silts and clays. Regular nuisance flow into the Basin promotes a variety of riparian and wetland vegetation along the low flow channels. Higher elevations in the Basin have variety of native and non-native vegetation. SBCFCD regularly cuts/sprays invasive vegetation and excavates/re-grades the low flow channels in the Basin.

Proof of Concept Approach

A wide variety of approaches may be used to estimate the infiltration rate of an existing basin. These methods range from very small scale, short duration and inexpensive methods with significant uncertainty, to very large scale, long duration and expensive methods with a much higher level of confidence in the test results. During preliminary development of the Wineville Basin PoC, a wide range of methods were considered. Some of the potential methods that can be used to predict the performance of a basin include:

1) Geotechnical Borings and Cone Penetrometer Testing (CPT) – These methods sample or otherwise measure the soil properties in the basin. They provide an indirect means to estimate infiltration rates into the basin bottom, and groundwater movement under the basin. These methods are typically done to gather data early on in a basin assessment.
    a. Advantages – This testing is relatively quick, inexpensive and has very low environmental impact; it provides data deep into the sediments below the basin bottom; and a large area can be covered in a short period of time.
    b. Disadvantages – These methods do not provide a direct measurement of infiltration rates, infiltration rates must be inferred through the measurement of soil properties; they only sample a very small percentage of the overall basin sediments; and, depending on the sampling interval, can fail to identify thin impeding layers.
2) Double Ring Infiltrometer Testing – Uses two concentric rings placed on the ground. Both rings are supplied with water. The outer ring is meant to saturate the area around the inner ring, promoting only vertical movement of water in the inner ring resulting in the measured infiltration rate.
    a. Advantages – This testing is relatively quick, inexpensive and has very low environmental impact.
    b. Disadvantages – This method tests only a very small area and measured rates can vary dramatically from full scale basin performance; very labor intensive; and must be done by well-trained personnel.
3) Test Pits or Trenches – This method is done by excavating trenches or pits into the basin bottom. The trenches are then filled to a given depth with water and the infiltration rates measured. The process is repeated multiple times.

   a. Advantages – This method is relatively inexpensive and multiple basin bottom elevations can be tested.
   b. Disadvantages – Infiltration rates are typically exaggerated due to excessive lateral movement of water. This approach will not "stress" the groundwater table enough to identify groundwater mounding constraints.

4) Test Cells – A number of smaller "basins" are excavated within the overall basin. The test cells are filled with water and then water levels are allowed to drop and infiltration rates measured. The process is repeated multiple times to develop a infiltration rate decay curve.
   a. Advantages – Lower cost than partial or full basin tests; this approach can cover a large enough area to translate well to a full basin condition; it is possible to control many of the variables that would otherwise lead to inconclusive test results (such as water quality, nuisance flow and source water quantity); and, it allows you to differentiate between higher or lower performing areas within a basin.
   b. This approach will likely not "stress" the groundwater table enough to identify groundwater mounding constraints; and, it is more expensive than approaches 1-3.
5) Partial Basin Test – A large portion of a basin is isolated from the rest of the basin and operated as a small groundwater recharged basin.
   a. Advantages – Will provide accurate estimation of the overall basin performance and will help to identify constraints for the full scale implementation; and, may identify basin mounding conditions.
   b. Disadvantages – Very expensive and time consuming to implement; and, very difficult to control basin variables and find/supply a temporary water source for testing.
6) Full Basin Test – The entire basin is tested in a condition similar to that of full scale implementation. The basin is temporarily modified to capture, control and measure flows and infiltration rates.
   a. Advantages – Will provide very accurate assessment of potential basin performance; and, if test is operated long enough, it will identify groundwater mounding issues.
   b. Disadvantages – Very expensive to set the basin up for testing and to limit variables which affect test data; requires significant cost and effort to supply a reliable quantity and quality of water for testing; will not identify higher or lower performing areas of the basin; can have large environmental impacts and costs; and, the cost to properly prepare a basin for a full-scale test quickly approaches the cost to implement the full scale project.

Table 1 below identifies the various approaches considered when developing the Wineville PoC, including a summary of the advantages and disadvantages of each approach.

Table 2: PoC Approach Selection

Method	Size (% of Basin Tested)	Duration of Test	Relative Cost	Confidence Level of Test Results	Advantages	Disadvantages
Borings/CPT	<< 0.0001 %	NA	Low	Very Low	Fast, easy and relatively low cost to identify soil characteristics, can characterize sediments and conditions deep under the basin	Very small % of basin is tested and no direct measurement of infiltration rates
Double Ring Infiltrometer	< 0.001 %	1 to10 days	Low	Very Low	Fast, easy and relatively low cost, provides measurement of infiltration rates	Can be very difficult to translate results to full basin condition
Test Pit/Trench with Water	≈0.01 %	10 to 30 days	Low	Low	Fast, easy and relatively low cost, provides measurement of infiltration rates, allows multiple basin elevations to be tested	Can be difficult to translate results to full basin condition, and will NOT identify basin mounding conditions
Test Cells	≈5 %	30 to 120 days	Medium	Medium	Provides reliable data, allows multiple basin elevations to be tested, can identify higher or lower performing areas of the basin	Will likely NOT identify basin mounding conditions
Partial Basin Test	≈20-50 %	> 60 days	High	Medium-High	Tests large portion of basin and it <u>may</u> identify mounding conditions. May identify better performing areas of the basin	Very expensive and difficult to control variables. Difficult to supply adequate water of consistent quality for testing
Full Basin Test	> 80 %	> 60 days	High	High	Tests entire basin and it <u>may</u> identify mounding conditions if operated long enough	Very expensive and difficult to control variables. Does not identify higher or lower performing areas of the basin

Proof of Concept Project Design

Existing Data

The use of existing data from previous studies/investigations was used in the design of the PoC. The development of the PoC Project relied on two previous efforts focused on characterizing the subsurface conditions in Wineville Basin and estimating infiltration rates. The two primary sources of existing data used in the PoC design included:

1) URS Memorandum, dated January 9, 2002: Inland Empire Utility Agency (IEUA) Infiltration Basin Study, Infiltration Rate Evaluation for Recharge Basins, including attachment titled Wineville Basin Infiltration Evaluation Summary, received March 12, 2002; and
2) Wildermuth Environmental Inc. Draft Report, dated October 16, 2009: Subsurface Investigation of the Wineville Basin – Draft Report.
    1. URS Report Summary
        a. A total of 7 borings (max depth of 82 feet below ground surface (bgs)) and 3 test pits (max depth of 16 feet bgs) were done to characterize the subsurface conditions.
        b. Subsurface geology was variable with layers if clay, silt sand and some gravels. Some continuous layers of low permeable material.
        c. Estimated infiltration rate from 0.01 – 0.10 ft/day (assumes 15 feet of basin bottom is excavated and removed).
    2. Wildermuth Environmental, Inc. Summary
        a. A total of 1 boring (max depth of 70 feet bgs) and 16 Cone Penetrometer Tests (CPT) to and average depth of 70 feet bgs were done to characterize the subsurface conditions.
        b. Some fine grained layers exist, but not continuous or abundant enough to prevent infiltration. Western portion of the Basin generally has more fined grained sediments than the central and eastern portions of the Basin. Recommend performing a full scale basin test to identify infiltration rates.
        c. Boring 1 (located in the approximate center of the Basin) had an average vertical component of hydraulic conductivity (K) of approximately 1.2 ft/day with minimum and maximum values ranging from 0.01 ft/day to over 7 ft/day.

Exploratory Excavations

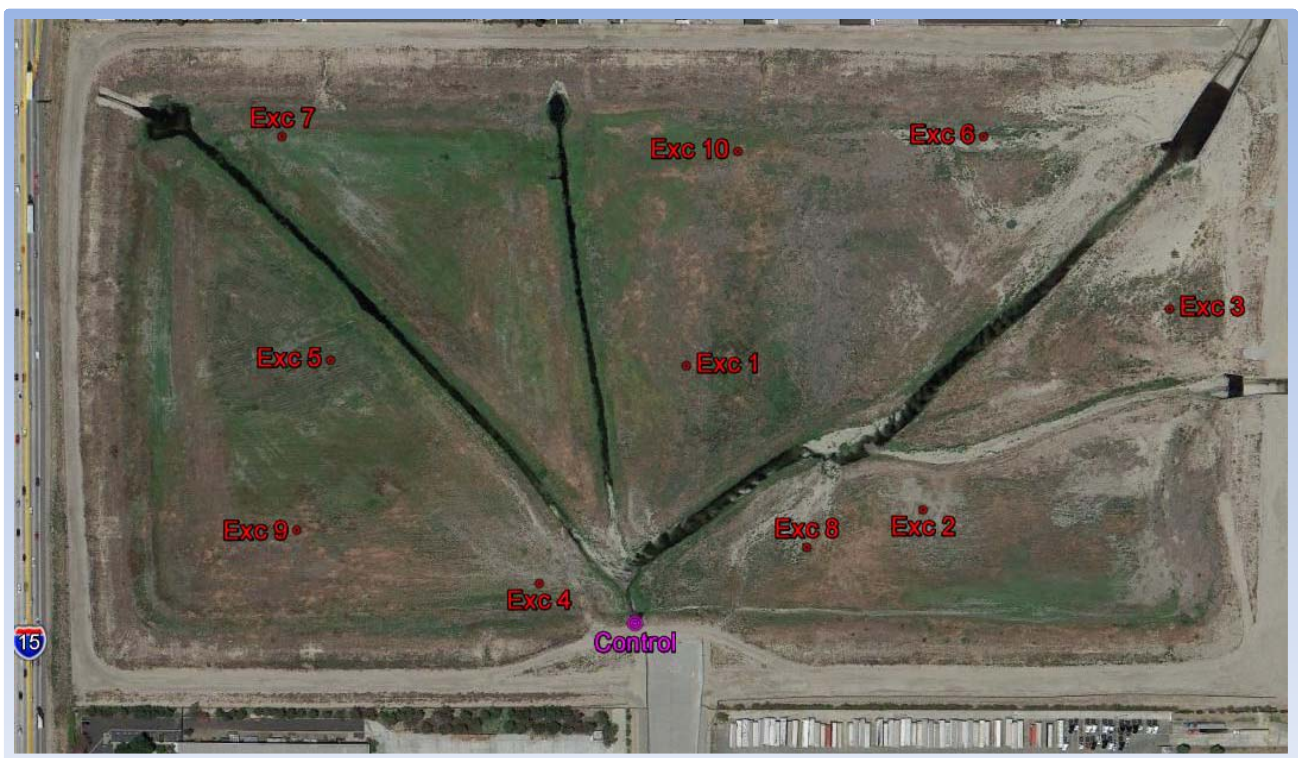
Prior to the final design of the PoC, exploratory excavations were performed to identify the current conditions in the Basin and characterize the near-surface (10 feet bgs or less) sediments in which the Percolation Test Cells (PTCs) would be constructed and operated. The excavations also provided insight as to the sedimentation trends in the

Basin due to recent storm events. Close investigation of near-surface sediments are important, because it is in this range that it can be cost-effective to remove or modify the basin sediments resulting in increased infiltration rates.

The locations for the exploratory excavations were selected based on multiple factors. The locations selected provide a wide sampling of the Basin in the areas most likely to be chosen for infiltration rate testing. The excavations were also positioned to provide additional insight on the results from previous borings, test pits and CPTs performed by URS and Wildermuth Environmental.

A total of ten locations were identified for excavation (Figure 3). Of the ten pre-selected locations, seven were actually excavated. The excavations were performed on December 19, 2012. A multiple day storm, which occurred two days prior to the excavations, resulted in wet conditions in the Basin. Standing water in the western 1/3 of the Basin prevented any excavations in that area. While the rain prevented completing excavations #5, #7 and #9, it did benefit the remaining explorations by providing adequate moisture to identify shallow impervious layers resulting in perched groundwater.

Figure 3: Proposed Exploratory Excavations



The excavations were performed using a tracked excavator. Each excavation was completed to a depth of 10 feet and soil samples were collected at 1-foot intervals. The samples were visually classified and the soil classification from each of the excavations can be seen in Table 3 below. It should be noted that no lab work was performed on the soil samples. Visual classifications may vary from actual lab analysis. The soil sample classification table (Table 3) includes color-coding to aid in the interpretation of each layer of soil. The qualitative interpretation is as follows: green shaded cells indicate "good" infiltration potential; yellow indicates "fair" infiltration potential; and red indicates "poor" infiltration potential. During field classification of the soils, the in-situ properties were taken into consideration. For example, highly compacted layers of silty sand (SM) are anticipated to have poor infiltration rates, whereas the same class of soil in a less compacted condition may allow for fair infiltration rates.

A field survey was performed to identify the horizontal locations of the excavations and the elevations. IEUA employed Cal Vada Surveying, Inc. to supply benchmark elevations based on the NAVD 88 datum. Scheevel Engineering used the benchmark elevations to determine the mean sea level (msl) elevation at the ground surface of each excavation.

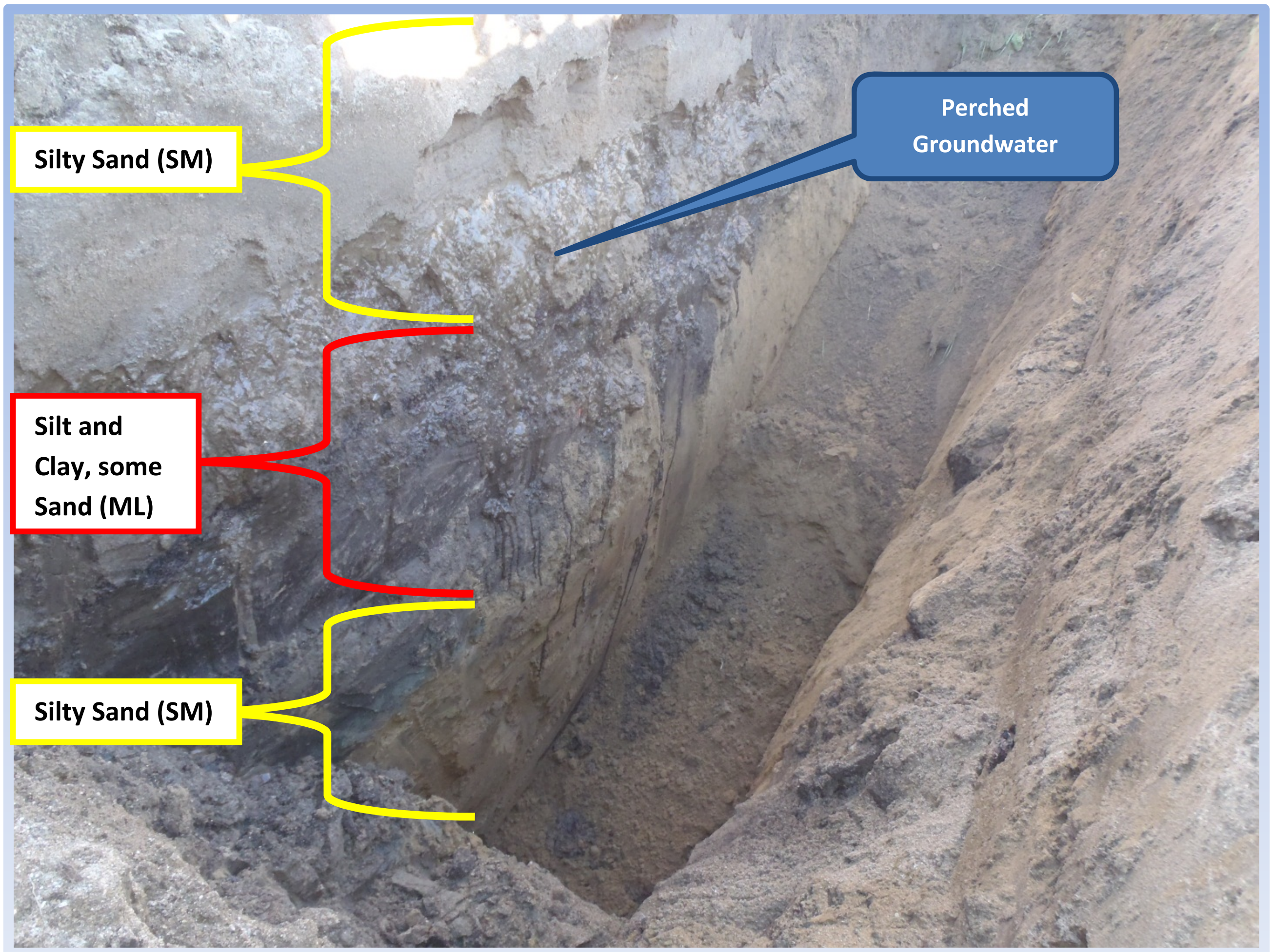
Table 3: Soil Classification

Elevation	Exploratory Excavation ID Number							
(msl)	1	2	3	4	6	8	10	
869.0	-	-	SP	-	-	-	-	
868.0	-	-	SW	-	-	-	-	
867.0	-	-	ML	-	-	-	-	
866.0	-	-	SM	-	SP	-	-	
865.0	-	SP	SM	SM	MH	SM	-	
864.0	SM	SW	SM	SM	SM	SM	SM	
863.0	ML	SM	SM	MH	SW	ML	ML	
862.0	MH	MH	SM	ML	SM	ML	ML	
861.0	MH	SM	SP	CL	SC	ML	CL	
860.0	SM	SM	SP	ML	SM	SM	CL	
859.0	SP	SP		ML	SM	SM	SM	
858.0	SP	SP		CH	SP	SM	SM	
857.0	SP	SP		SP	SP	SM	SM	
856.0	SP	SP		SP		SM	SM	
855.0	SP						SM	
Latitude	34°02'33.4"	34°02'30.6"	34°02'34.5"	34°02'29.2"	34°02'37.8"	34°02'29.9"	34°02'37.5"	
Longitude	117°32'44.7"	117°32'39.2"	117°32'33.5"	117°32'48.1"	117°32'37.8"	117°32'41.9"	117°32'43.5"	

SW = Well Graded Sand Little Fines, SP = Poorly Graded Sand Little Fines, SM = Silty Sand Poorly Graded, SC = Clayey Sand Poorly Graded, ML = Inorganic Silts and Finer Sands Clayey Sand, CL = Inorganic Clays Sandy Clay, MH = Inorganic Silts, CH = Inorganic Clay

The exploratory excavations revealed semi-impervious layers throughout the Basin. The recent rainfall and inflow into the Basin resulted in perched groundwater, which highlighted the semi-impervious layer. Perched groundwater in excavation #8 can be seen in Figure 4.

Figure 4: Photo of Exploratory Excavation #8



The exploratory excavations summarized above reveal several important characteristics about the Wineville Basin:

1. The top 5-7 feet appear to have been deposited after the Basin was constructed. This is evident by the presence of organic matter and debris found during the excavations.
2. Each of the excavations performed revealed a semi-impervious layer, which will impede infiltration rates. This layer varies in thickness and generally exists from 2-5 feet below the existing ground surface.
3. The semi-impervious layer may significantly restrict infiltration rates. This was evident while performing the excavations, as perched groundwater was encountered in many of the excavations.
4. In order to quantitatively assess the influence of the apparent semi-impervious layer, two phases of infiltration rate testing were recommended for some of the test cell locations. Phase 1 of testing should occur within the top 1-2 feet of the existing basin bottom (just above the impervious layer). Phase 2 should include

select test cells (in the same locations as Phase 1) excavated below the semi-impervious layer. By comparing test results, a determination can be made whether it will be cost effective to remove some or all of the near surface semi-impervious material.

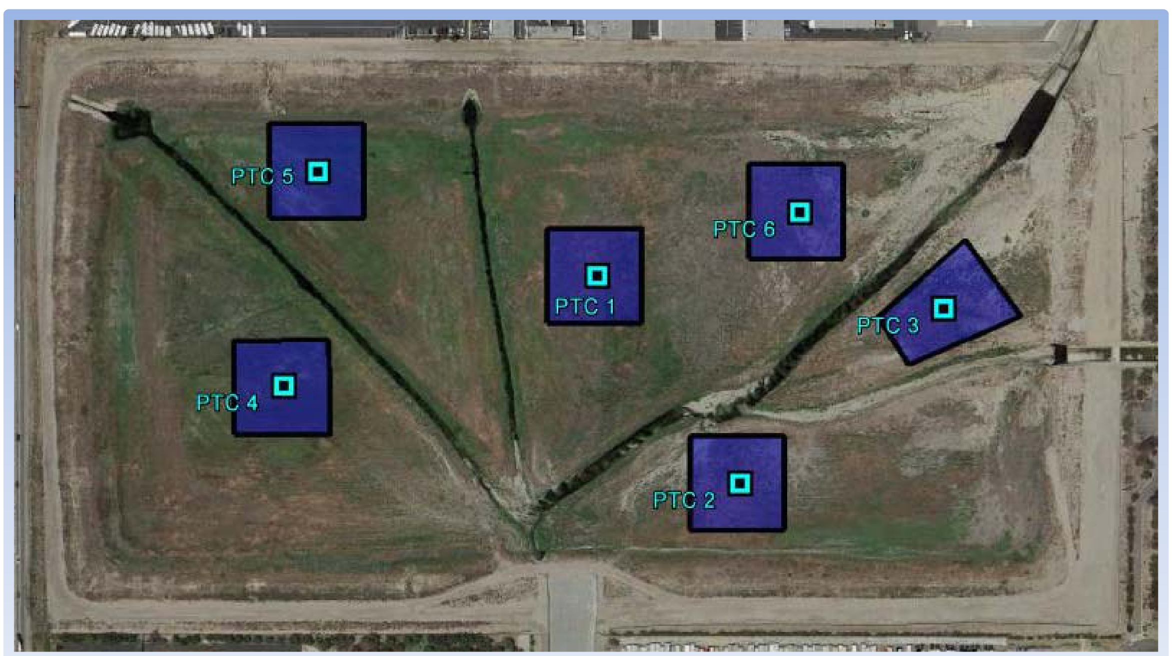
5. The exploratory excavations presented here are relatively shallow. Deep sediment layers may exist that would impede infiltration rates and create groundwater mounding. Also, the area of the PTCs will be relatively small compared to the overall surface area of the Basin, and lateral infiltration rates may be exaggerated during testing. This can occur because PTCs have a larger perimeter/area ratio when compared to the entire basin perimeter/area ratio, allowing more lateral infiltration in the PTCs.

Final Design

The final PoC arrangement selected for Wineville Basin was a test cell approach. This approach provided the best balance of cost, environmental impact, schedule, control of test conditions variability and confidence in test results. Data from the previous studies/investigations from URS, Wildermuth Environmental and Scheevel Engineering were used to determine the horizontal and vertical placement of six PTCs.

The PTCs were spatially distributed over the Basin in order to collect data relevant to the variable geology within the Basin. Two PTCs were placed in the western 1/3rd, two PTCs in the central 1/3 and two PTCs were positioned it the eastern 1/3rd of the Basin (Figure 5).

Figure 5: Test Cell Layout



The PTCs were positioned so as not to interfere with the low flow channels in the Basin. In order to test the infiltration rates above and below the near surface impeding layers, it was decided to test each 1/3rd of the Basin and two elevations. Test cells #2, #4 and #6 were excavated to 6-7 feet bgs, and test cells #1, #3, and #5 were excavated to 2-3 feet bgs.

Initially, a two-phase infiltration rate test was planned for the PoC. Phase 1 testing would have included all six PTCs being operated within the top 1-2 feet of the existing basin bottom (just above the impervious layer) for up to 45 days. Phase 2 would have included three of the original test cells excavated below the impervious layer (6 to 7 feet bgs) and operated for up to 45 days, while the three remaining shallow PTCs continued to operate concurrently. Environmental and schedule restraints dictated that a shorter duration test protocol be developed. This resulted in a 60-day test with three of the PTCs operated at 2-3 feet bgs (shallow) and three PTCs operated at 6-7 feet bgs (deep).

Each of the PTCs covered approximately 0.5 acres (3 acres total) of the basin bottom. A temporary 12-inch diameter pipeline was constructed from Day Creek Channel in the north-east corner of the Basin. A temporary sand bag diversion berm was constructed in the channel to create the proper hydraulic conditions to feed the pipeline. Each of the test cells was equipped with a 6-inch diameter turn-out. This allowed each PTC to be filled and isolated from each of the other cells. Each of the PTCs was equipped with staff gauges and level loggers to measure infiltration rates.

Temporary low-flow channel crossings were constructed to support the temporary pipeline and allow for access to the PTCs during testing. An evaporation monitoring station was also temporarily constructed in the Basin to monitor evaporation rates during testing.

Proof of Concept Project Implementation

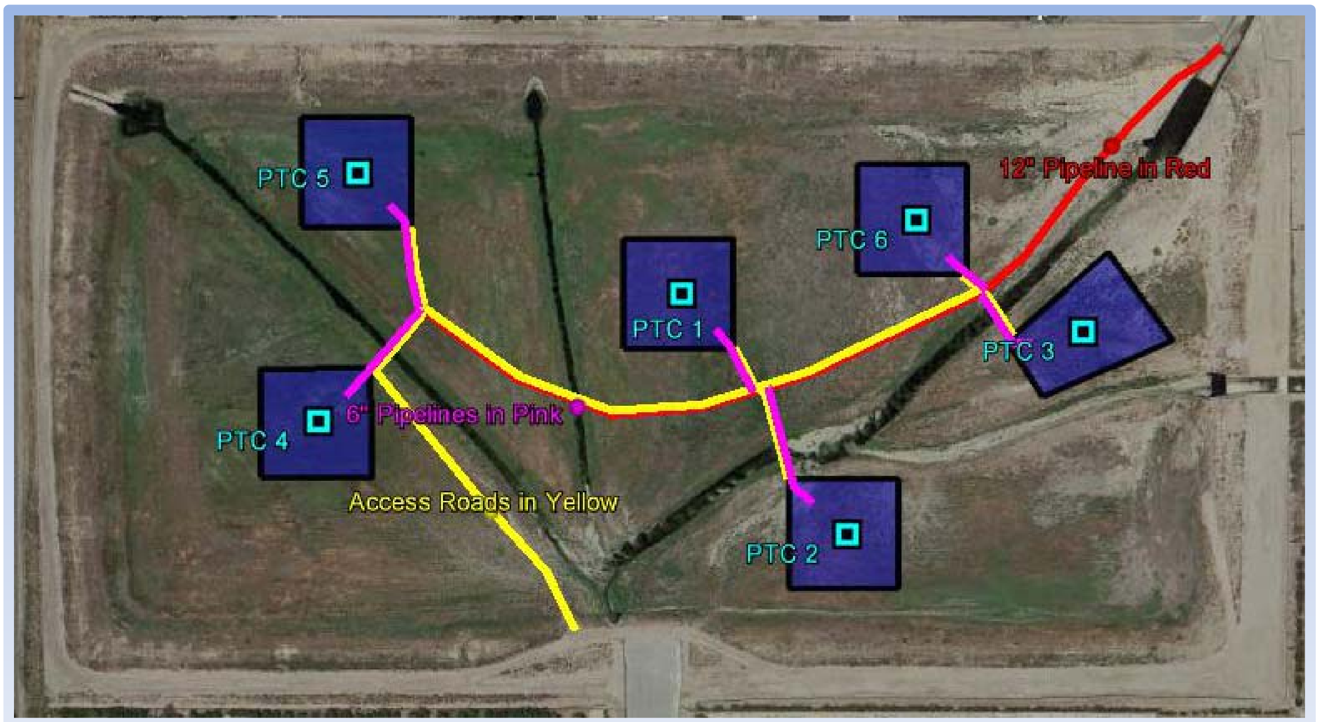
Overview

The Wineville Basin Proof of Concept Project was advertised and awarded as a public works project. A construction contract was awarded for the project in June 2013 with construction occurring in September of 2013. Permit requirements dictated that construction activities occur outside of nesting bird season, and that the testing be complete and the Basin returned to its original condition by December of 2013. This affectively allowed testing to occur during October and November of 2013.

Construction

Construction activities included excavating the PTCs by using a bulldozer to push the sediments out of the PTCs. A perimeter berm was formed around each of the PTCs with the excavated sediments. Each PTC was approximately 0.5 acres in size. A 12-inch diameter mainline was supplied by the contractor and placed from Day Creek Channel to the western portion of the Basin. 6-inch diameter lateral pipes were constructed from the mainline to each of the PTCs (Figure 6 and 7). Flow control valves and energy dissipaters were also constructed to provide a means to control the flow into each of the PTCs. A Storm Water Pollution Prevention Plan (SWPPP) was prepared and implemented for the project as well.

Figure 6: PoC Test System Layout



Day Creek Channel was determined to be the best conveyance for water to the Basin. Day Creek channel was selected because it is situated at the highest elevation in the Basin (conducive to a gravity fed pipeline system), it is concrete-lined (helping to control water quality) and it is situated near several upstream water sources that were candidates to provide supply water for testing.

A temporary sand bag berm, approximately 3-feet high, was constructed across Day Creek Channel to impound water and create the necessary hydraulic conditions to feed the pipeline.

A total of four low-flow channel crossings were constructed by placing 36-inch diameter pipes in the channels and then covering them with soil excavated from the nearby PTCs.

The crossings provided vehicle access to the PTCs, as well as an area to support the temporary pipelines across the channels. A wooden 2x6 was imbedded 3 feet vertically into the bottom of each PTC. This provided the support to mount a staff gauge and a pvc stilling well to house the data loggers used to collect level data.

A stainless steel evaporation pan with a stilling well and micrometer (National Weather Service, Class A) was placed in the bottom of the Basin near PTC #4. The evaporation pan was placed level and slightly elevated off of the ground with a wooden frame. A perimeter chain-link fence was constructed around the pan to limit disturbance of the pan by wildlife.

Figure 7: Typical PTC Inlet and Staff Gauge

Once all testing was complete, the pipelines, crossings, berms and all equipment were removed from the Basin. The PTCs were then backfilled with the native soils and the site was returned to its original condition.

Operation/Data Collection

The data collected for the PoC included the evaporation pan data, staff gauge data, PTC level logger data and the barometric pressure logger data. A number of daily qualitative observations were also made and recorded as a part of the project.

Evaporation measurements were collected to correct infiltration rate data for each PTC. The evaporation rate corrections to the PoC data was insignificant to the overall results; however, it is included in the following analysis for completeness. Had the PoC been implemented during the summer months (when evaporation rates are higher), or had the PTC infiltrations rates been much lower, then the evaporation correction would have been more significant to the outcome of the PoC.

Staff gauge data was used to provide a daily assessment of the PTC performance, calibrate the level logger data, provide back-up data in the event that level logger data was compromised and plan the day-to-day operation of the water delivery system (pipelines) and personnel staffing requirements.

The level logger data was used to collect continuous level data in each of the PTCs. This data was calibrated and checked against the staff gauge data to assure consistency and accuracy in the test results.

Barometric pressure logger data was used to correct the level logger data for changes in the barometric pressure.

Once construction was complete and the pipes and valves were tested and inspected for leaks, the system was put into operation. Two to three PTCs were filled simultaneously. Once the water elevation reached from 1.5 to 3 feet in the PTC (as determined by visual observation of the staff gauges), the valve to the PTC was closed and a starting depth and time was manually recorded, the cell was then monitored until the depth was below 0.5 feet, the time and depth was recorded, infiltration rate calculated and then flow was delivered to the test cell once again and the process repeated. Level logger data was periodically downloaded from each PTC and compared to the staff gauge data to assure consistency in the test data.

Evaporation pan readings were taken at regular intervals and the data was checked against locally available evaporation data to assure accuracy. Evaporation rates were subtracted from measured infiltration rates to avoid an overestimation of PTC performance. Daily inspections and notes were taken of the site conditions, in an attempt to identify any conditions that could have resulted in anomalous data readings.

Figure 8: PTC #6 Filling

Figure 9: PTC #5 In Operation

The PTCs were put into operation on October 1, 2013 and testing was terminated on November 26, 2013. During the test period, water was supplied by the City of Ontario - Well 30. Well 30 delivered flow to Day Creek Channel, the Channel would then deliver flow to the 12-inch pipeline, and then onto the PTCs.

During the implementation of the PoC, three separate storm events occurred. These storm events resulted in sufficient local inflow to interrupt the test and cause minor damages to the test system.

1) The first storm event occurred on October 9, 2013, resulting in approximately 0.06 inches of rainfall. Minor damage occurred to the sand bag berm and inlet pipe requiring repairs to the system.
2) The second storm event occurred on October 28, 2013, resulting in approximately 0.11 inches of rainfall. Minor damage occurred to the sand bag berm, low flow crossings and PTC #2, including storm flow intrusion into PTC #2.
3) The third storm event occurred on November 20, 2013, resulting in approximately 0.23 inches of rainfall. No additional damages resulted from this storm event.

Data Analysis and Results

Summary of Results

Data analysis was performed several times throughout the implementation of the project to assure that the data being collected was reasonable and usable. Level logger data was corrected for barometric presser and evaporation and then compared to the staff gauge data (also corrected for evaporation). Each PTC was plotted to develop an infiltration rate decay curve and those decay curves were used to estimate the infiltration rates for the PTCs. PTC infiltration rates were then compared against their respective locations and elevations in the Basin to draw conclusions about each PTCs performance, relative to the known geological conditions in that area of the Basin. Ultimately, a projected infiltration rate for the Basin was estimated considering the PoC results and known conditions of the Basin.

Infiltration rates are measured in feet per day (ft/day), otherwise defined as the vertical change in water elevation over a 24-hour period. A typical infiltration rate decay curve has a high initial value during, and immediately after a basin is filled, or when the elevation is dramatically increased. This phenomenon is due to the initial saturation of the previously dry sediments in the basin. Air- filled void space in the soil is rapidly filled with water, resulting in an artificially high infiltration rate. As the air voids are filled with water, the infiltration rate "decays" to a more sustainable rate. Other factors that affect the decay curve (and ultimately sustainable infiltration rate) are water quality (primarily total suspended solids (TSS)) and groundwater mounding. Infiltration rates presented in this should be considered a likely sustainable rate utilizing supplemental water as the source water.

Stormwater infiltration rates will be highly dependent on TSS and should be estimated at a lower value than what is presented here. The following section (Wineville Basin Projections) provides an estimate of stormwater infiltration rates. Stormwater infiltration at the Wineville Basin should be expected to vary from year to year, depending on basin cleaning frequency, upper watershed conditions and storm frequency and intensity.

In general the deeper PTCs performed better than the shallower PTCs (Figure 10 and Table 4), with the exception of PTC #6, which may be explained by a semi-impervious layer deeper in that area of the Basin (recall that the even # PTCs were excavated deeper than the odd # PTCs).

A likely infiltration rate estimate for the Wineville Basin in its current condition is approximately 0.24 ft/day. Higher infiltration rates may be possible with extensive basin cleaning or over-excavation, but should be approached in measured and carefully planned steps. An infiltration rate of 0.24 ft/day was arrived at by comparing all of the PTC test results, considering each PTC location in the Basin (both horizontally and vertically) and considering information from subsurface investigations.

When looking at the results for all six of the test cells, PTC#1 ranked in the lowest 1/3 of the group, providing a conservative projection for the Basin. PTCs #2, #4, and #6 were all excavated deep (6 to 7 feet) into the Basin bottom through the near-surface confining layer. The higher infiltration rates observed in PTCs #2, #4, and #6 are largely due to their vertical placement in the Basin. Replicating this condition will be costly due to the over-excavation required to reach these depths. The proposed basin configuration is to keep the Basin bottom elevation similar to the existing condition. Therefore it is advisable to use data from PTCs that are at or near existing Basin elevations.

The results from PTC #3 (0.64 ft/day) are believed to be higher than the achievable overall Basin average because PTC #3 is situated at a higher elevation, atop sediments coarser than the average sediments found in the Basin.

During the construction of PTC #5 it was found that the near surface sediments are made up primarily of densely packed silts and clays. This information, coupled with historical observations of long-term standing water in this area, ranked this PTC infiltration rate as the most conservative outcome for full scale implementation. Because the rest of the Basin has near-surface conditions more favorable than PTC #5 it is believed that this observed infiltration rate (0.13 ft/day) is a worst case scenario for the Basin.

PTC #1 was located in the approximate geographic center of the Basin and at an elevation near the existing Basin bottom. Some near-surface fine grained sediments are present in this area of the Basin. The sustained infiltration rate from PTC #1 (0.24 ft/day) is believed to be a good representation of the future performance of the Basin in its current condition.

Figure 10: Wineville Basin PoC Infiltration Rate Results

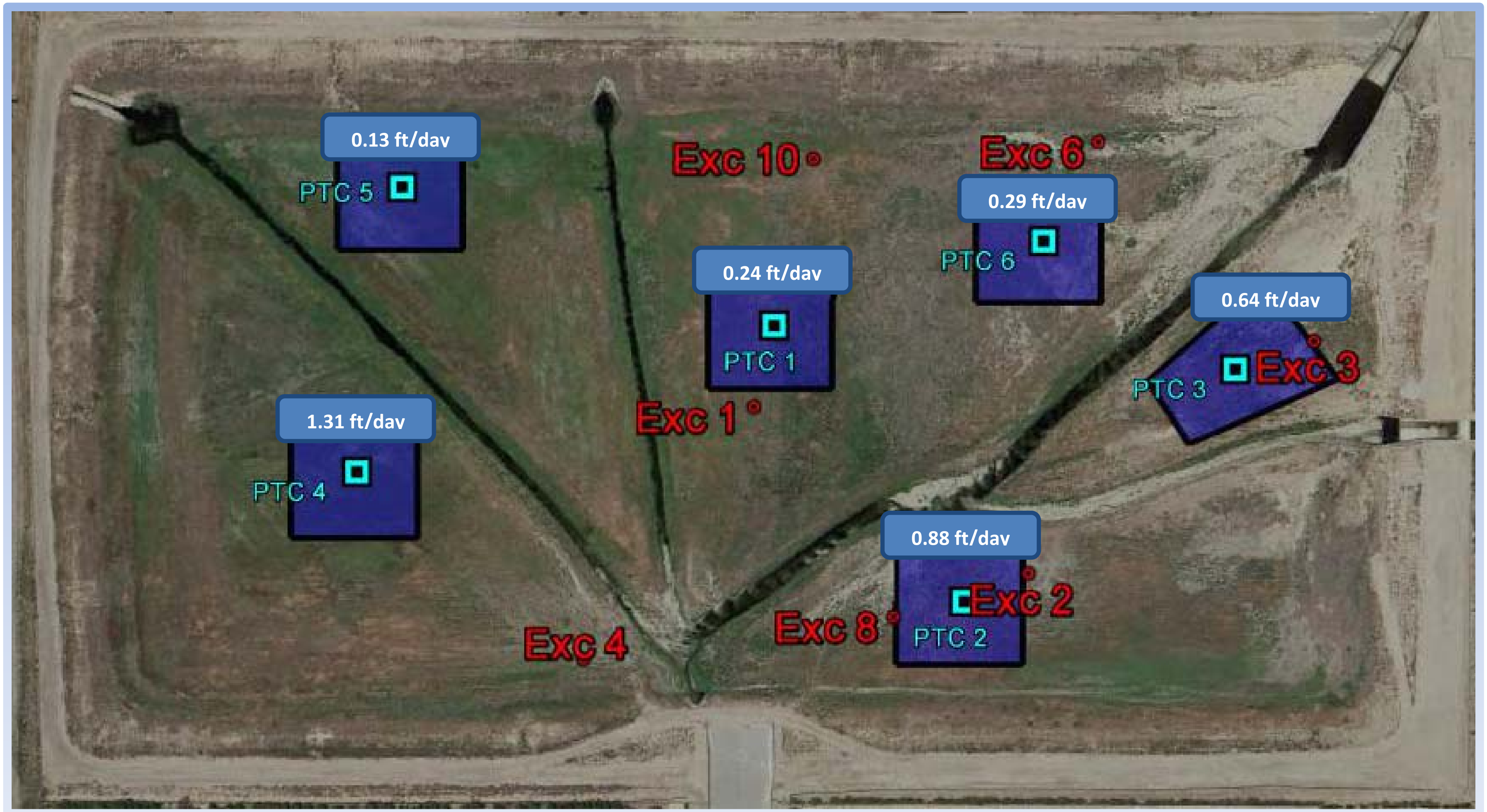


Table 4: PTC Bottom Elevation Soil Type

	Exploratory Excavation with Test Cell Bottom Elevation															
(msl)	Exc 1	PTC 1	Exc 2	PTC 2	Exc 3	PTC 3	Exc 4	PTC 4	Exc 6	PTC 6	Exc 8	PTC 2	Exc 10	PTC 6	No Exc	PTC 5
869	-		-		SP		-		-		-		-			
868	-		-		SW		-		-		-		-			
867	-		-		ML		-		-		-		-			
866	-		-		SM	**866.8**	-		SP		-		-			
865	-		SP		SM		SM		MH		SM		-			
864	SM		SW		SM		SM		SM		SM		SM			
863	ML		SM		SM		MH		SW		ML		ML			
862	MH	**862.2**	MH		SM		ML		SM	**862.3**	ML		ML	**862.3**		
861	MH		SM		SP		CL		SC		ML		CL			**861.3**
860	SM		SM		SP		ML		SM		SM		CL			
859	SP		SP	**859.4**			ML		SM		SM	**859.4**	SM			
858	SP		SP				CH	**858.5**	SP		SM		SM			
857	SP		SP				SP		SP		SM		SM			
856	SP		SP				SP				SM		SM			
855	SP												SM			
PoC Infil. Rate (ft/day)		**0.24**		**0.88**		**0.64**		**1.31**		**0.29**		**0.88**		**0.29**		**0.13**

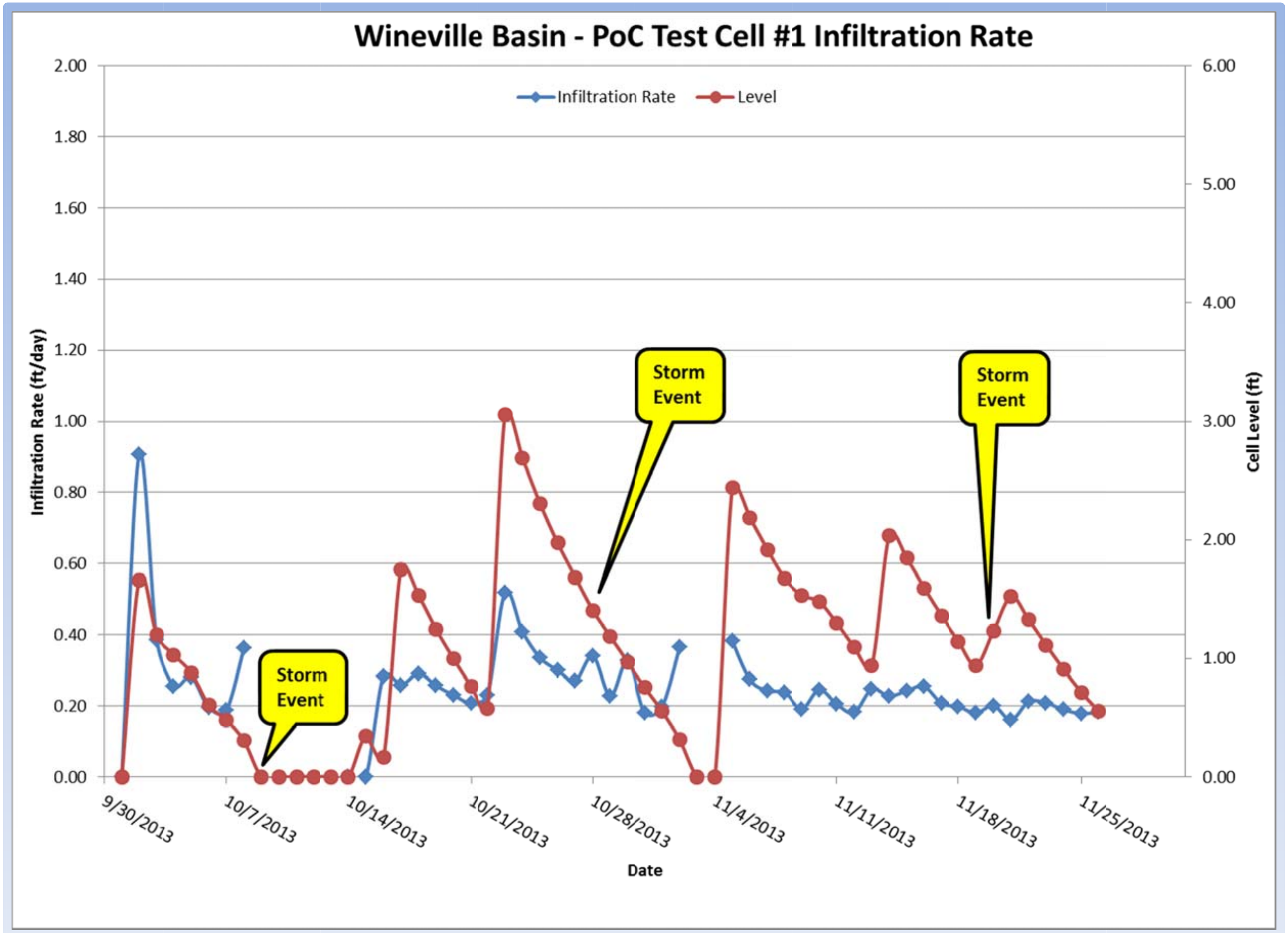
Test Cell #1 Results

Test Cell #1 was located in the central 1/3rd of the Basin (east to west) and in the approximate center of the Basin (north to south). The bottom of the PTC was positioned at elevation 862.2, approximately 2.5 feet below the existing ground surface, within a zone of semi-impervious sediments.

PTC #1 had a sustained infiltration rate of approximately 0.24 ft/day, with little variability in the last 20 days of testing. Even as the water level varied between 0.5 to 2.5 feet, the infiltration rate held nearly constant at an average of 0.22 ft/day. This reveals a high level of confidence in the observed infiltration rate at this location in the Basin. The PTC #1 infiltration rate should be considered a somewhat conservative estimate for the Basin, given that it was the 2nd lowest observed rate in the Basin. The rate for PTC #1 is used in Scenario #2 in the next section of this report. It should also be noted that an infiltration rate of 0.24 ft/day is nearly identical to the Wildermuth Environmental projected rate (0.25 ft/day) for the Wineville Basin presented in the Chino Basin Watermaster 2013 Amendment to the 2010 Recharge Master Plan Update (RMPU).

Figure 11 below shows the PoC infiltration rates, along with the corresponding water level. The three previously discussed storm events have been annotated on the figure for reference. Data gaps in the infiltration rate indicate a period of time when the PTC water level was zero due to operational constraints.

Figure 11: PTC #1 Graph



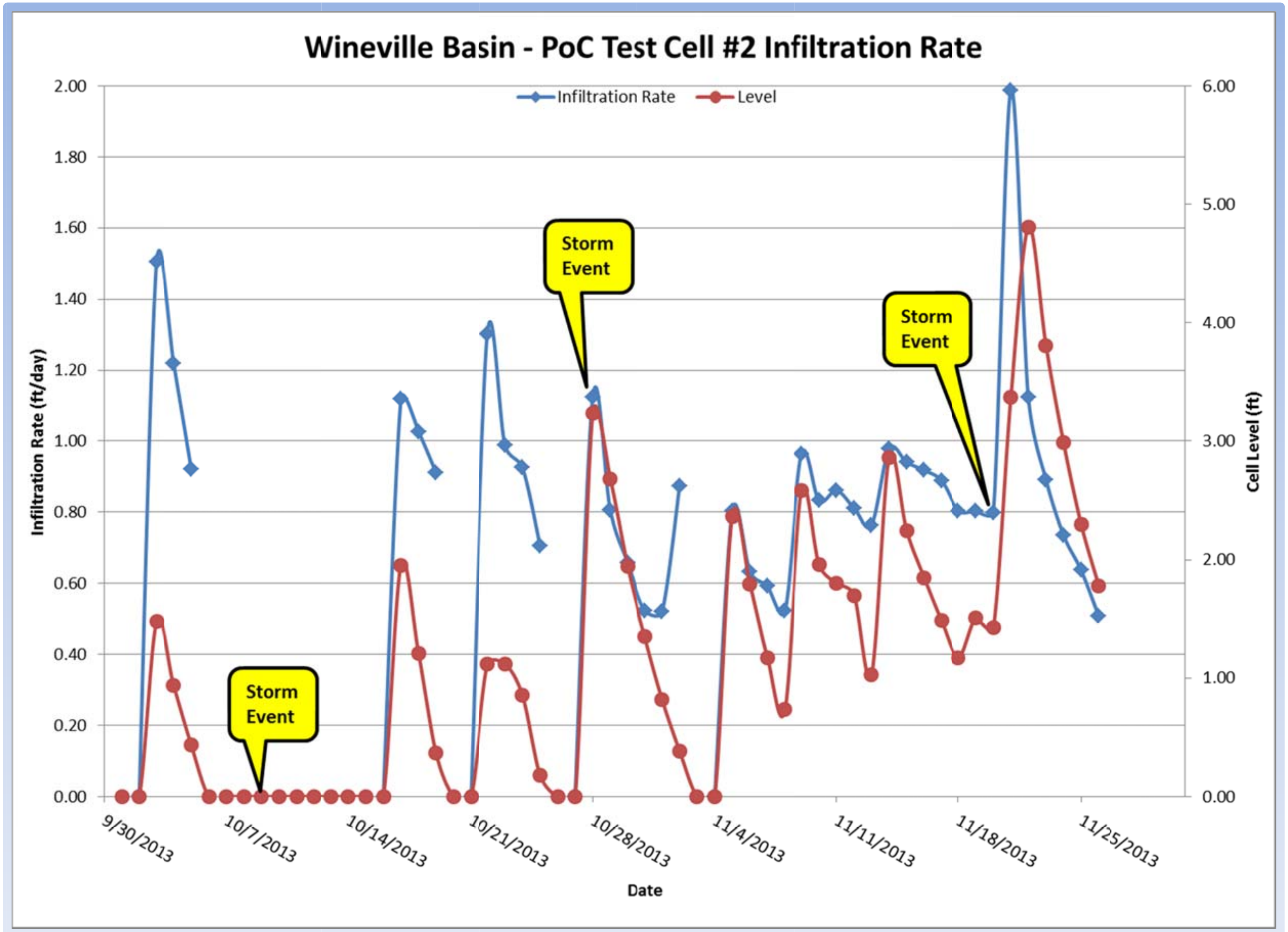
Test Cell #2 Results

Test Cell #2 was located in the central 1/3rd of the Basin (east to west) and along the southern edge of the Basin closest to the existing Basin drain. The bottom of the PTC was positioned at elevation 859.4, approximately 7 feet below the existing ground surface, more than 2 feet below the uppermost zone of semi-impervious sediments.

PTC #2 had a sustained infiltration rate of approximately 0.88 ft/day, with significant variability during testing. This variability in the test data is due to relatively high infiltration rate and the associated difficulty of keeping a consistent water level in the PTC. The PTC #2 infiltration rate should be considered an aggressive estimate for this area of the Basin, given that it was located at a depth much lower than the existing Basin bottom. The infiltration rate for PTC #2 may be achievable with a major basin reconfiguration and for short periods of time. Groundwater mounding may become the limiting factor at this observed infiltration rate.

Figure 12 below shows the PoC infiltration rates, along with the corresponding water level. The three previously discussed storm events have been annotated on the figure for reference. Data gaps in the infiltration rate indicate a period of time when the PTC water level was zero due to operational constraints.

Figure 12: PTC #2 Graph



Test Cell #3 Results

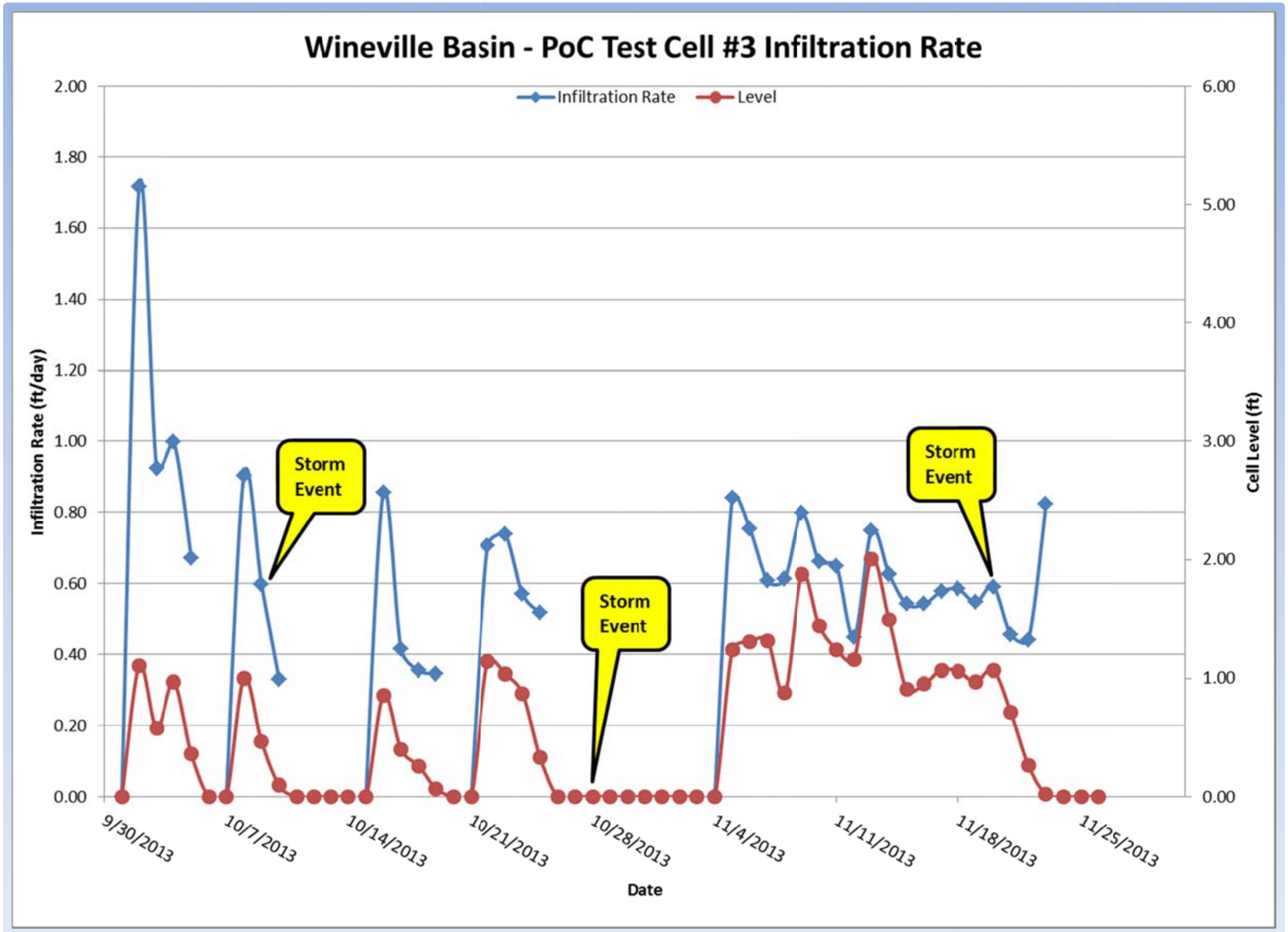
Test Cell #3 was located in the eastern 1/3rd of the Basin and slightly to the north of the Basin centerline (north to south). The bottom of the PTC was positioned at elevation 866.8, approximately 3 feet below the existing ground surface, just below a zone of semi-impervious sediments. The bottom of PTC #3 was more than 4 feet higher than any other PTC bottom.

PTC #3 had a sustained infiltration rate of approximately 0.64 ft/day, with moderate variability in the first 30 days of testing and low variability in the last 20 days of testing. The variability in the test data is due to relatively high infiltration rate and the associated difficulty of keeping a consistent water level in the PTC. The PTC #3 infiltration rate should be considered a reasonable estimate for this area of the Basin, given that it was located at a relatively shallow depth and much of the near-surface sediment in this area is coarser in nature due to the sediment depositional patterns created by Day Creek Channel and Lower Etiwanda Creek Channel.

PTC #3 was located relatively close to two of the low flow channels in the Basin and some lateral movement of water could have resulted in slightly higher observed infiltration rates. Regular inspections were performed in the low flow channels to attempt to identify lateral moment of water but no seepage at the surface was observed.

Figure 13 below shows the PoC infiltration rates, along with the corresponding water level. The three previously discussed storm events have been annotated on the figure for reference. Data gaps in the infiltration rate indicate a period of time when the PTC water level was zero due to operational constraints.

Figure 13: PTC #3 Graph



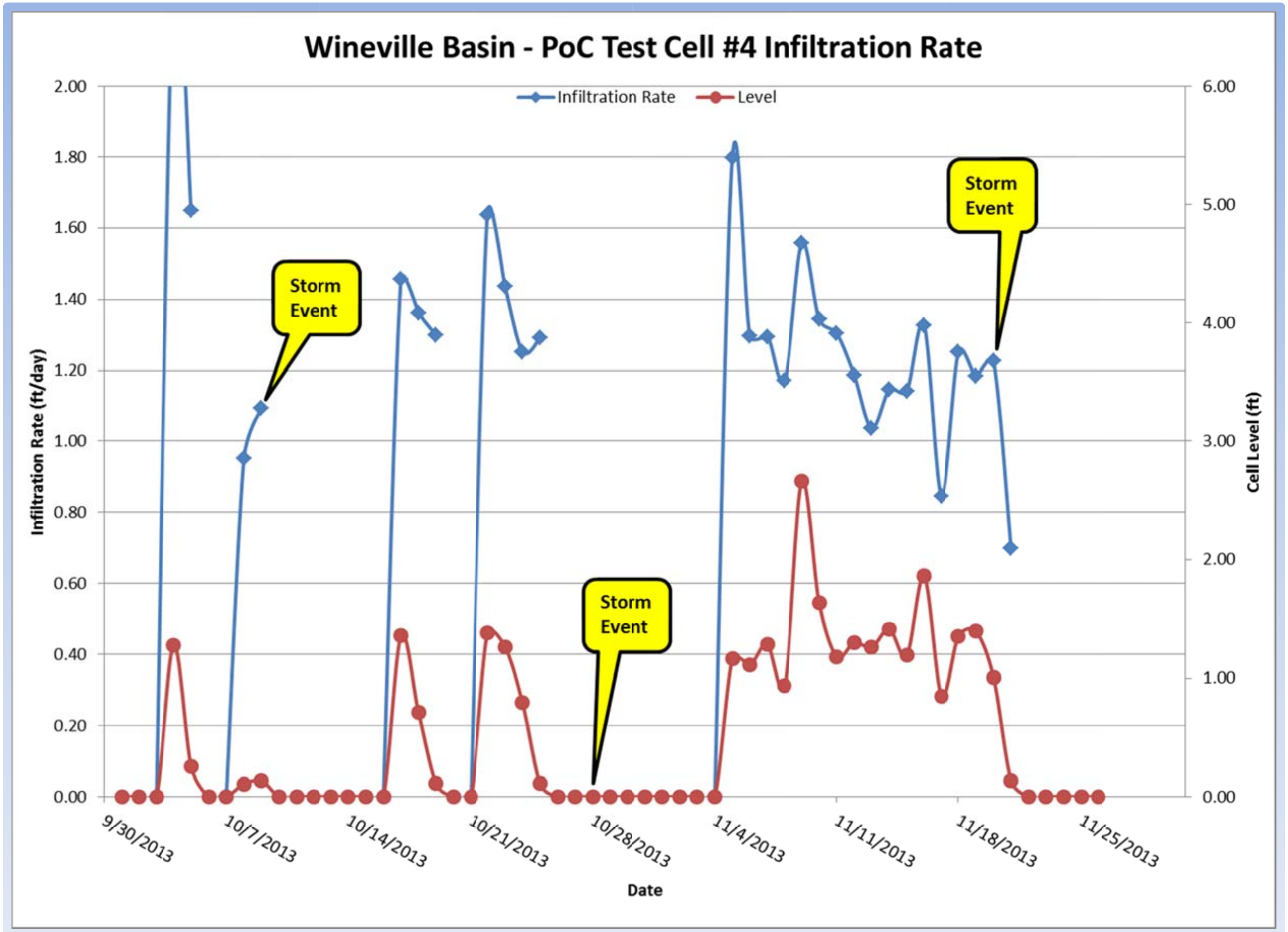
Test Cell #4 Results

Test Cell #4 was located in the western 1/3rd of the Basin within the southern half of the Basin (north to south). The bottom of the PTC was positioned at elevation 858.5, approximately 7 feet below the existing ground surface, just below the uppermost zone of semi-impervious sediments.

PTC #4 had the highest sustained infiltration rate of approximately 1.31 ft/day, with relatively low variability in the infiltration rate given the large variation water level. The variability in the test data is due to relatively high infiltration rate and the associated difficulty of keeping a consistent water level in the PTC. The PTC #4 infiltration rate should be considered an aggressive estimate for this area of the Basin, given that it was located at a depth much lower than the existing Basin bottom. The infiltration rate for PTC #4 may be achievable with a major basin reconfiguration for short periods of time. Based on previous subsurface investigations, groundwater mounding will likely become the limiting factor as deeper impeding layers will likely restrict the infiltration rate.

Figure 14 below shows the PoC infiltration rates, along with the corresponding water level. The three previously discussed storm events have been annotated on the figure for reference. Data gaps in the infiltration rate indicate a period of time when the PTC water level was zero due to operational constraints.

Figure 14: PTC #4 Graph



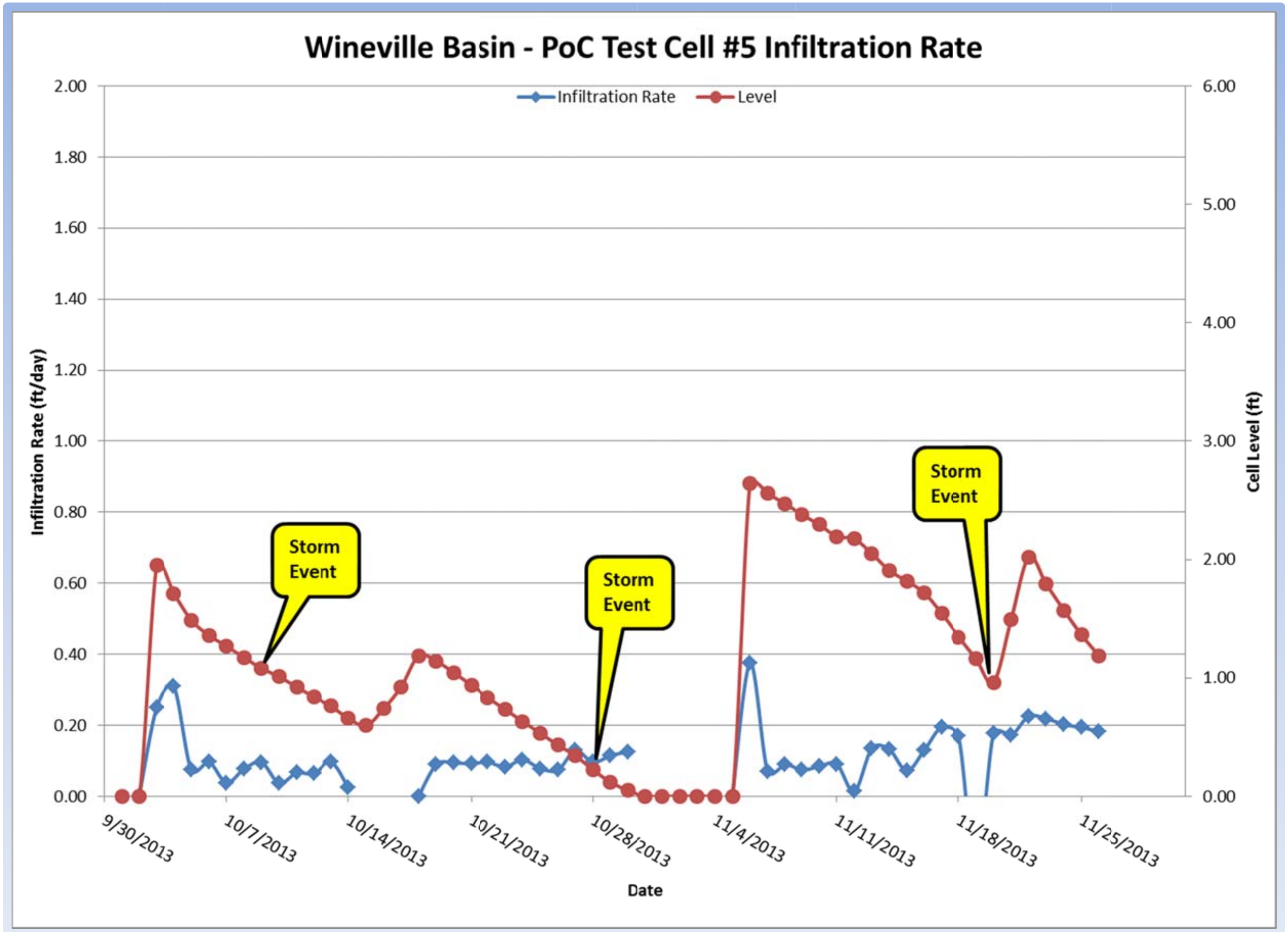
Test Cell #5 Results

Test Cell #5 was located in the western 1/3rd of the Basin and in the northern 1/2 of the Basin (north to south). The bottom of the PTC was positioned at elevation 861.3, approximately 2 feet below the existing ground surface, within a zone of semi-impervious sediments as discovered during construction of the PTC.

PTC #5 had a sustained infiltration rate of approximately 0.13 ft/day, with little variability throughout testing. Even as the water level varied between 0.05 to 2.6 feet, the infiltration rate held nearly constant at an average of 0.15 ft/day. This reveals a high level of confidence in the observed infiltration rate at this location in the Basin. The PTC #5 infiltration rate should be considered a very conservative estimate for the Basin, given that it was the lowest observed rate in the Basin. The rate for PTC #5 is used in Scenario #1 in the next section of this report.

Figure 15 below shows the PoC infiltration rate, along with the corresponding water level. The three previously discussed storm events have been annotated on the figure for reference. Data gaps in the infiltration rate indicate a period of time when the PTC water level was zero due to operational constraints.

Figure 15: PTC #5 Graph



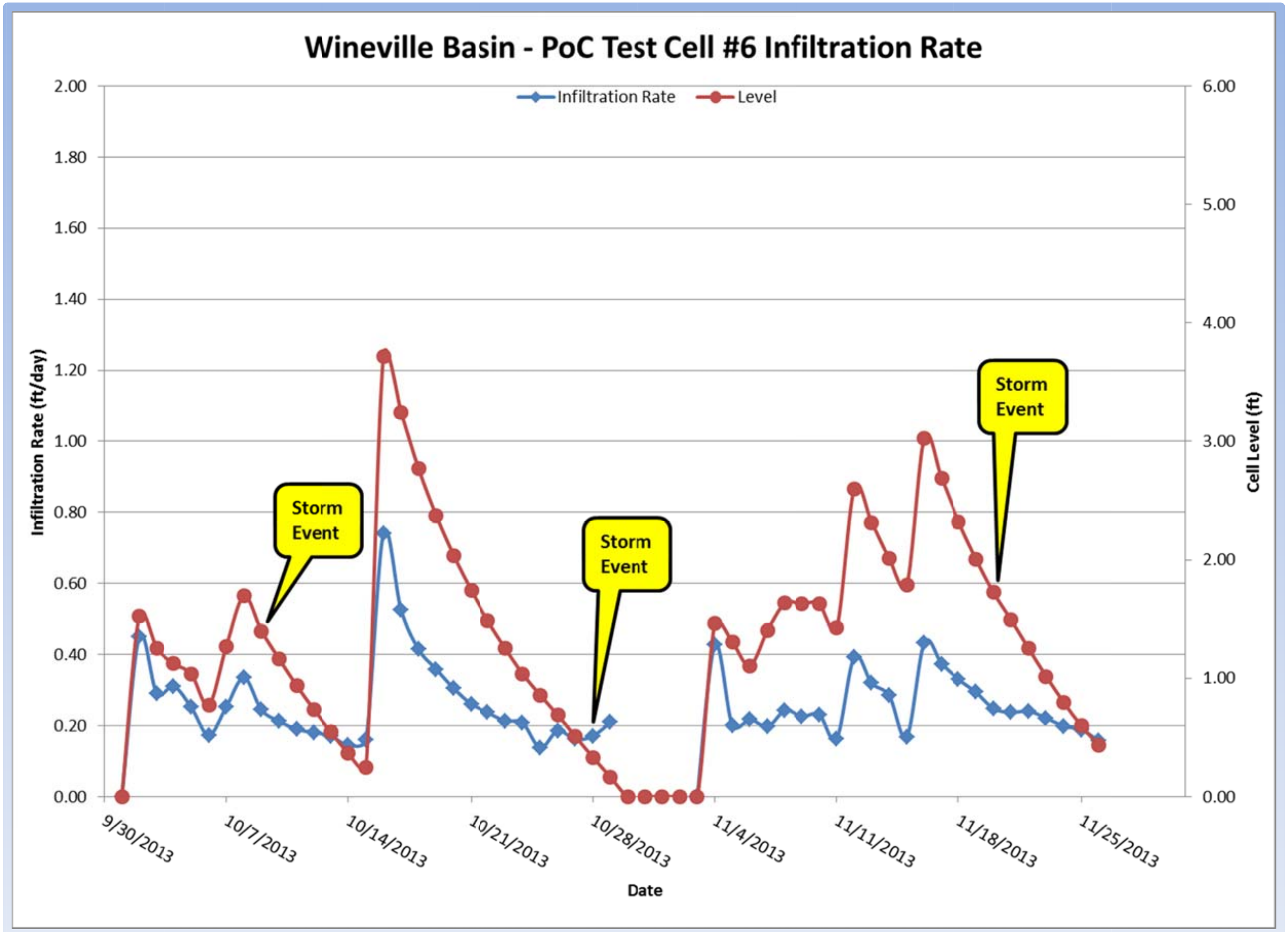
Test Cell #6 Results

Test Cell #6 was located in the eastern 1/3rd of the Basin and in the northern 1/2 of the Basin (north to south). The bottom of the PTC was positioned at elevation 862.3, approximately 4 feet below the existing ground surface, within a zone of semi-impervious sediments.

PTC #6 had a sustained infiltration rate of approximately 0.29 ft/day, with significant variability at higher water levels. As the water level exceeded 0.5 feet the infiltration rate increased accordingly. This reveals a lower level of confidence in the observed infiltration rate at this location in the Basin and indicates more lateral movement of water as the level increases. Exploratory excavations reveal that the bottom of PTC #6 may have been positioned in a semi-impervious layer of sediment, with coarser sediments just above the bottom of the PTC, resulting in more lateral movement of water than what should be expected in a full basin operational scenario.

Figure 16 below shows the PoC infiltration rates, along with the corresponding water level. The three previously discussed storm events have been annotated on the figure for reference. Data gaps in the infiltration rate indicate a period of time when the PTC water level was zero due to operational constraints.

Figure 16: PTC #6 Graph



Wineville Basin Projections

Scenario Development

The following Wineville Basin performance projections are based on data collected during the PoC. A conservative approach was taken when developing the projections. The range of observed sustainable infiltration rates varied from 0.13 ft/day to 1.31 ft/day. In order to provide a realistic projection, two scenarios were developed which provide a range of the anticipated basin infiltration rates.

After collecting and analyzing the field data, along with the previous subsurface investigations, it was determined that the performance of PTC #1 and PTC #5 will most closely mimic the full-scale Basin performance in its current condition. Both of these test cells displayed relatively constant infiltration rates, despite large variations in the water level. This indicates that little of the infiltration was occurring laterally, which can often be the case in a test cell arrangement. As water levels in a basin increase, new surface are is wetted and the opportunity for lateral infiltration into the basin perimeter slopes increases. During the PoC in PTCs #1 and #5 this phenomenon was not observed, thereby indicating that lateral infiltration played a small part in the overall infiltration rates of these two PTCs.

Higher infiltration rates from the deep PTCs were not used to develop Basin performance projections for several reasons:

1) The PoC was not operated on a large enough scale or for a long enough period of time in order to determine if the higher infiltration rates would result in groundwater mounding. Basin over-excavation would be unwarranted if initially higher infiltration rates were soon restricted by deeper subsurface impervious layers.
2) A significant effort and cost would be required to over-excavate the Basin to depths (>5 feet) below the observed near-surface semi-impervious sediments.
3) A measured approach can be used to develop the Basin for full-scale implementation. Once operational data and experience is gained with the Basin in its current condition, future aggressive cleanings or over-excavations in portions of the Basin will provide reliable data to estimate the benefit of a large scale reconfiguration.

The two lowest observed infiltration rates from the PoC were used in the development of Scenario #1 and Scenario #2. These projections should be achievable with only minor Basin modifications. Both scenarios assume that minor Basin cleaning/re-grading occurs along with the construction of Basin outlet modifications and the construction of supplemental water turnouts to the Basin. A portion of the perimeter embankments of the Basin may need reconstruction as well. It would be advisable to design the new structures/improvements to accommodate a future deepening of the Basin in the event that future full-scale basin testing supports it. It should be noted that these Basin modifications are consistent with recommendations presented in the 2013 Amendment to the 2010 RMPU.

A number of operational scenarios are possible for Wineville Basin, and each year the operation of the Basin will vary. One hypothetical sequence of events is presented here for both scenarios. The assumptions that are included in this model are:

1) Based on an analysis provided by Wildermuth Environmental, a number of rain events are likely to occur throughout the year. Each event results in inflow to the Basin, and with Basin improvements, some or all of these storm flows can be captured and infiltrated into the Basin.
2) The Basin is operated at elevation 876 (approximately 58 acres of wetted area).
3) The Basin is taken out of service in April of the first year and cleaned to remove the sediments deposited during the previous storm season(s). Basin cleanings would then be dictated by performance and operational objectives.
4) Supplemental water is supplied to the Basin for 2 months immediately after the spring cleaning event.
5) Supplemental water delivery is halted for 1 month to allow any potential groundwater mounding to dissipate. This may be a conservative assumption.
6) Supplemental water is supplied to the Basin for 2 months immediately after the midsummer break.
7) Supplemental water delivery is stopped and the Basin is taken out of service for 2 weeks for minor maintenance and to prepare the Basin for the storm season.
8) The Basin is dedicated to storm flows from October through April. Infiltration rates decline as the Basin bottom clogs due to TSS in the stormwater. The decay rate will vary from year to year.
9) During the storm season, 1-2 days prior to a storm event, the Basin elevation is dropped to allow for adequate flood control storage.
10) During the non-storm season, the Basin is operated at elevation 856 and any storm flows are “absorbed” into the Basin pool.

The following scenarios assume that the Basin is cleaned in the spring of the first year of operation. This cleaning will remove fine grained sediments that will be deposited by storm flows during the previous year(s). Cleaning the Basin after the storm season, and early in the non-storm season, will allow for higher Basin performance throughout the summer months, thereby achieving the highest possible supplemental water recharge rates.

Higher sustained recharge rates may result in groundwater mounding under the Basin. A one-month period has been added during the summer of these scenarios to allow the mound (should it develop) to dissipate. Groundwater mounding may or may not be a factor in long term Basin performance and can only be entirely identified by full scale implementation/operation.

These scenarios also assume that supplemental water deliveries are terminated in mid-October to reserve the Basin for subsequent stormwater flows. It is anticipated that infiltration rates of the initial stormwater flows will be similar to the rates of supplemental water. However, due to the suspended solids in stormwater, infiltration rates will inevitably decay as the Basin floor clogs with fine grained sediments. This infiltration rate decay will vary depending on TSS concentrations, particle size distribution, storm frequency, storm intensity and Basin operations.

The scenarios presented here assume an infiltration rate decay of approximately 40% to 50% over six months. Without long-term operational data to develop a Basin specific infiltration rate decay curve an alternative method was used to model this data. Other groundwater recharge basins in the region with similar attributes were analyzed. Three basins in the lower Santa Ana River Watershed, which receive stormwater, and act as flow through Basins (similar to Wineville Basin) were considered. Previous, detailed analyses were done to estimate infiltration rate decays of these sample basins. Long term monitoring of the infiltration rates and associated TSS concentrations of these sample basins were used to develop the decay curves presented in the following scenarios.

The graph for each of the following scenarios shows stormwater present in the Basin throughout the storm season. This condition is due to the increased operating elevation of the Basin and additional stormwater capture capacity of the Basin made possible by the proposed improvements. The existing Basin drains empty after each storm event which results in lost stormwater capture/recharge potential. Only incidental stormwater recharge occurs in the Basin immediately following a storm event.

Basin improvements will allow water to be stored up to elevation 878’, or approximately 18 feet of depth. This equates to approximately 950 acre-feet of storage. When the Basin water elevation is at 878’, and assuming an infiltration rate of 0.24 ft/day, it will take approximately 75 days to infiltrate all of the stored water into the ground.

On average there are approximately 16 storm events from October 15 to April 15 of any given year. Flood control restrictions as well as days between, and intensity of, rain events during a storm season will determine the actual observed water level in the basin and the amount of stormwater lost during any given year. The following analysis assumes that adequate stormwater is available from October 15 to April 15 to keep water in the Basin to maximize infiltration over the Basin bottom. In very dry years stormwater recharge will be supply limited. In moderate to very wet years the total amount of water recharged will be limited by the infiltration rate, which is the condition modeled in the following scenarios. Table #5 summarizes the hypothetical stormwater and supplemental water recharged in the Basin by month.

Table 5: Projected Recharge by Month

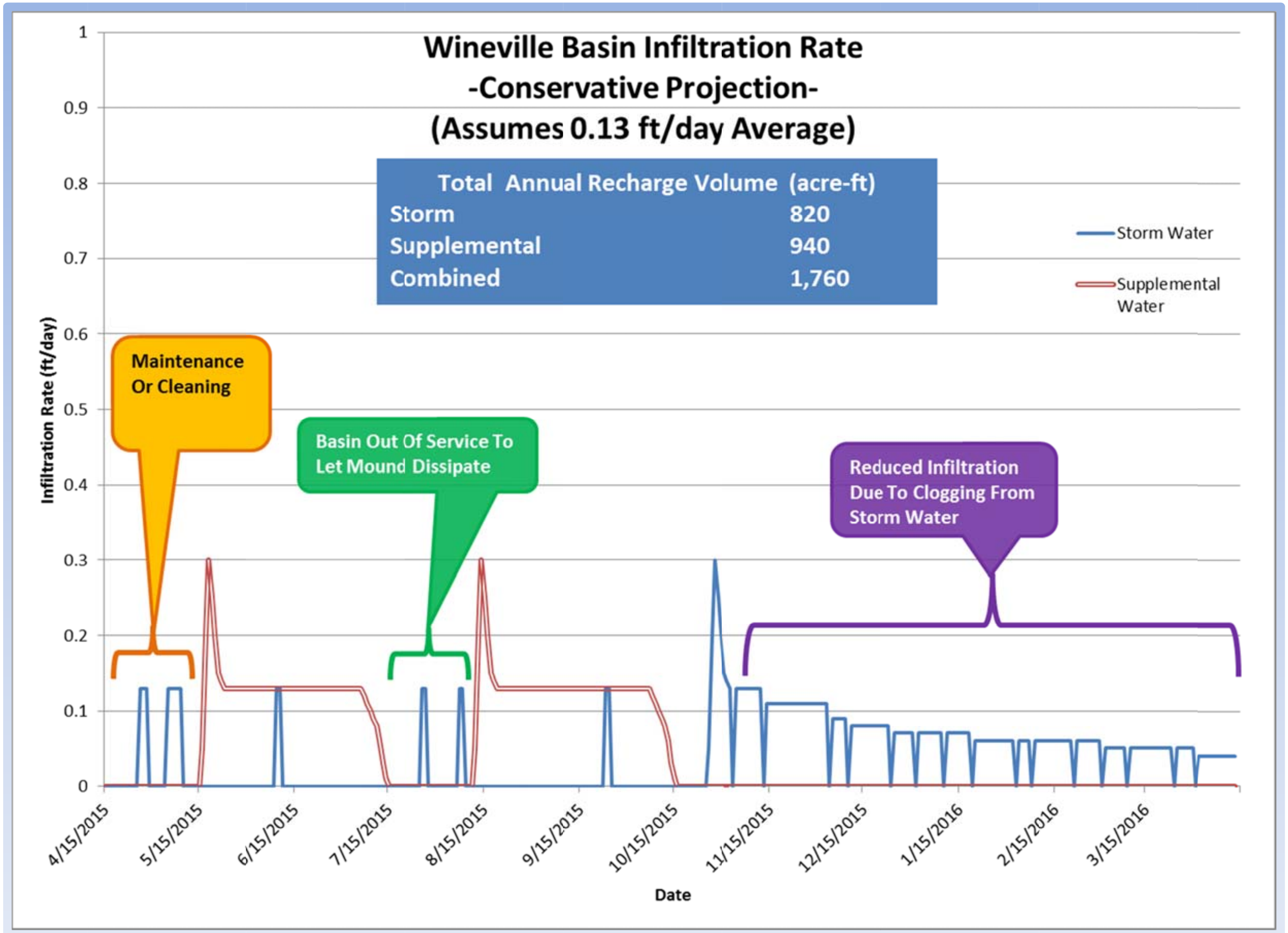
	Total Stormwater Recharged (acre-feet)		Total Supplemental Water Recharged (acre-feet)		Total Recharge (acre-feet)	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2
January	107	363	0	0	107	363
February	90	288	0	0	90	288
March	78	267	0	0	78	267
April	53	139	0	0	53	139
May	38	42	144	249	182	291
June	15	28	226	418	241	445
July	15	14	80	186	95	200
August	15	14	174	291	189	305
September	15	28	226	418	241	445
October	67	110	89	186	156	296
November	192	404	0	0	192	404
December	134	378	0	0	134	378
Total	819	2,073	939	1,748	1,758	3,821

At the end of the modeled year of operation (mid-April) the Basin infiltration rate should be expected to be lower than the “clean” Basin condition. This however, may not result in a mandatory cleaning each April. Basin cleaning may only be required every 2 years or as operational conditions and performance objectives dictate.

Scenario #1

This scenario was developed based on the lowest sustained infiltration rate observed during PoC testing. PTC #5 was located in the north-west quarter of the Basin in an area where standing water is regularly observed. Standing water can be indicative of fine grained sediments near the surface restricting infiltration rates. No exploratory excavations were performed in this area due to standing water. Figure 17 shows a hypothetical year of the Wineville Basin in operation, with an average sustained infiltration rate of 0.13 ft/day.

Figure 17: Wineville Basin Performance Projection – Scenario #1

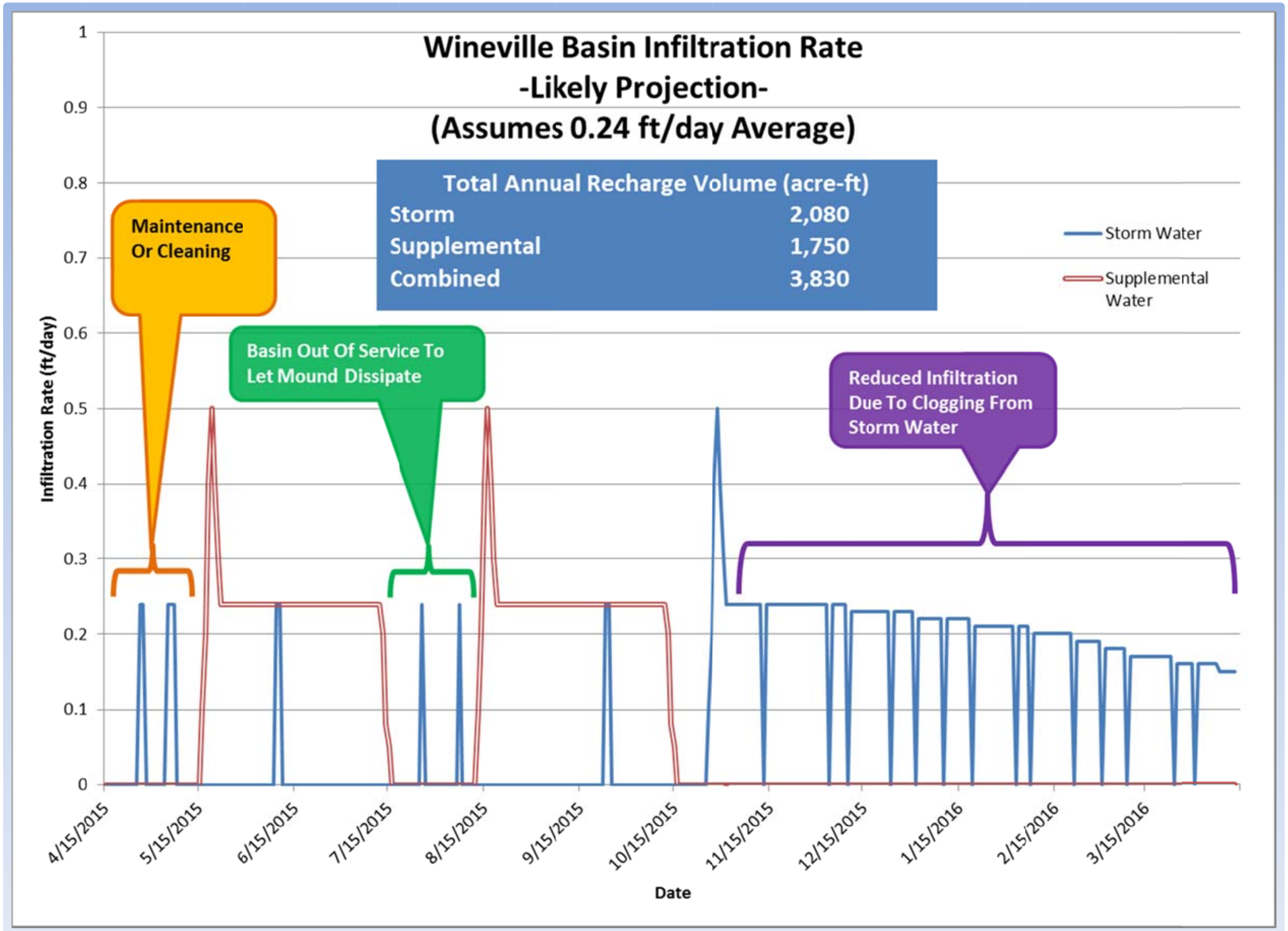


Scenario #2

This scenario was developed based on the 2nd lowest sustained infiltration rate observed during PoC testing. PTC #1 was located in the approximate center of the Basin. Exploratory excavations revealed fine grained sediments near the surface, likely resulting in the lower observed infiltration rates. This scenario is considered the most likely performance outcome should full- scale groundwater recharge operations occur at the Wineville Basin.

Figure 18 shows a hypothetical year of the Wineville Basin in operation, with an average sustained infiltration rate of 0.24 ft/day.

Figure 18: Wineville Basin Performance Projection – Scenario #2



Summary of Projections

Two likely scenarios were developed to help quantify the potential volume of additional storm and supplemental water that could be recharged into the groundwater basin annually. Based on PoC test results, the potential new stormwater capture and recharge ranges from 820 to 2,080 ac-ft/yr. The potential new supplemental water recharge ranges from 940 to 1,750 ac-ft/yr. These recharge projections assume minor basin grading, embankment reconstruction, the construction of flow control outlet structures and construction of supplemental water turnouts.

Table 6: Projected Basin Performance Summary

	Infiltration Rate	New Annual Stormwater Recharge	New Annual Supplemental Water Recharge	Total Annual Recharge
Scenario #1	0.13 ft/day	820 ac-ft/yr	940 ac-ft/yr	1,760 ac-ft/yr
Scenario #2	0.24 ft/day	2,080 ac-ft/yr	1,750 ac-ft/yr	3,830 ac-ft/yr

Basin Modifications

Existing Conditions

Wineville Basin controls flow from two large flood control channels and several smaller storm drains in the immediate vicinity of the Basin. The two largest tributaries to the Basin are Day Creek Channel and Lower Etiwanda Creek Channel. The bottom of Wineville Basin generally slopes from north to south delivering flows to a 72” diameter reinforced concrete pipe (RCP) drain located at the invert of the Basin (elevation 861.2 NAVD 88). The Basin drain pipe is currently un-gated, which allows the Basin to empty after each storm event. Storm events that produce inflows, which exceed the capacity of the Basin drain pipe, cause an increase in the water elevation in the Basin until elevation 871.2, at which point, flow exits the Basin and continues south in Day Creek Channel for approximately 0.65 miles until reaching Riverside Basin in Riverside County, CA.

In order to utilize the Basin as a dual purpose facility (flood control and groundwater recharge) a number of physical and operational modifications will be required. The Basin outlet will need to be controlled and a new supplemental water inlet will need to be constructed. Operationally, an agreement will need to be reached between SBCFCD and IEUA to determine storm and non-storm season operating levels, maintenance intervals and maintenance cost sharing.

Basin Modifications - Physical

In order to impound water in the Basin, the 72” drain will need to be modified and gated. It is beneficial to gate the drain because it will allow the Basin to be gravity drained for cleanings/maintenance, or if the water level needs to be lowered quickly prior to a storm event to provide adequate flood protection. Gating the drain will allow water to be stored up to the existing spillway height of 871.2.

Additional Basin capacity can be achieved by modifying the existing spillway to impound more water. Several options exist which are adjustable that would provide operational flexibility to meet flood control and groundwater recharge objectives. These include inflatable spillway gates, inflatable rubber dams and flow control gates of various designs.

A supplemental water turnout and pump station will also be required to deliver water to the Basin and dewater the Basin as needed. These improvements will likely be located in the south-east corner of the Basin to utilize the natural slope of the Basin and available space for pipelines and related facilities.

In order to operate the Basin at higher elevations for prolonged periods of time some reconstruction of existing embankments may be required. Minor Basin grading and cleaning should also be performed prior to operating the Basin for groundwater recharge purposes.

Basin Modifications - Operational

Currently, the Basin is operated with only flood control objectives in mind. Low flows pass through the Basin unobstructed. High flows that enter the Basin are temporarily detained and then drained out of the Basin through the 72” drain at rates dictated by the hydraulic characteristics of the piping.

To meet groundwater recharge objectives, stormwater and supplemental water would be stored in the Basin and allowed to infiltrate into the Basin bottom and side slopes. An operational plan will need to be developed, which maximizes groundwater recharge, while not adversely impacting the flood control function of the Basin. This would include identifying a maximum allowable recharge water level in the Basin during the storm and non-storm seasons. Developing supplemental water delivery guidelines (both schedule and quantity based) will help reduce the risk of losing supplemental water during a storm event. The development of basin drawdown procedures prior to storms forecasted of a given intensity may also be required to assure maximum flood control design capacities are preserved.

Cost Benefit Analysis

The proposed basin modifications included as part of this PoC evaluation are consistent with the modifications proposed in the 2013 Amendment to the 2010 Recharge Master Plan Update (2013 RMPU). Refer to Table 8-2a in the 2013 RMPU for the the project description, construction cost estimate and cost benefit analysis. Site plan modification drawings for the Wineville Basin can also be found on Figures D-27a and 27b of the 2013 RMPU.

Conclusions/Recommendations

The Wineville Basin Proof of Concept Project quantified the potential benefit of expanding groundwater recharge operations to Wineville Basin and enhancing artificial recharge into the Chino Groundwater Basin. Wineville Basin presents an opportunity to use an existing facility for the dual purpose of flood control and groundwater recharge. Because it is a flood control basin, the conveyance of stormwater to the Basin lends itself to stormwater capture and infiltration. Supplemental water could be delivered to the basin during non-storm periods, providing the opportunity to increase the annual recharge of supplemental water in the Chino Basin. Basin improvements will be required to perform artificial groundwater recharge at Wineville.

Two months of testing revealed a range of potential infiltration rates. Variation in the test results is primarily due to variable geology within the Basin. Six separate areas in the Basin were tested at various elevations. Sustained infiltration rates ranged from 0.13 ft/day to 1.31 ft/day. The most likely range of infiltration rates at Wineville Basin, should it be used for artificial recharge, ranged between 0.13 ft/day to 0.24 ft/day. This will provide an approximate annual benefit of new stormwater capture and recharge ranging from 820 to 2,080 ac-ft/yr, with the potential new supplemental water recharge ranging from 940 to 1,750 ac-ft/yr. A conservative estimate of 1,760 ac-ft to 3,830 ac-ft of water could be recharged at the Wineville Basin annually.

Initial Basin improvements should include outfitting the Basin to capture stormwater and accept supplemental water. These improvements should be designed with future full-scale Basin testing and reconfiguration in mind. Once the Basin has been put into service, and the initial benefits realized, full scale monitoring can be performed to assess the full potential of the Basin and optimize the final configuration.

References

Scheevel Engineering, Inc. (dated August 19, 2013); *Wineville Basin Proof-of-Concept Project Exploratory Excavation Final Report (Revision 1)*

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Wildermuth Environmental Inc. (dated October 16, 2009); *Subsurface Investigation of the Wineville Basin – Draft Report*

Wildermuth Environmental Inc., Black and Veatch Corporation, Wagner & Bonsignore, Sierra Water Group. (dated June 2010); *2010 Recharge Master Plan Update Final Report*

Wildermuth Environmental Inc. (dated 2013); 2*013 Amendment to the 2010 Recharge Master Plan Update*