# 3.0 Updated Hydrology

# 3.0 UPDATED HYDROLOGY

## 3.1 MODELING SYSTEM DEVELOPMENT

The Plan Update provides a new hydrologic modeling system that has significant technological advances over that used in the 1992 Plan. Though the 1992 Plan was state-of-the-art at the time it was prepared, the new modeling system is better able to evaluate flood flow timing that is significant to development impact and project analyses. Computer programs, including HEC-HMS and HEC-RAS, GIS software, and the DCDESKTOP software were employed to develop a new basis for watershed runoff and flood flow evaluation. The new modeling system includes substantially more detail than the 1992 modeling system allowing it to be used on smaller tributaries which will facilitate its application on smaller projects. Furthermore, the new modeling system has been calibrated using precipitation and stream flow gage data from the December 1995, December 2005, and January 2007 storm events to ensure the validity of the results. The new modeling system provides capabilities to evaluate Dry Creek hydrology in ways that were not possible with the models from the 1992 Plan, but are now necessary to adequately evaluate the potential impacts of projects on flooding conditions and provide a valid quantification of the benefits of mitigation measures.

The process that led to the development of the new modeling system started with updating the 1992 Plan hydrology model by applying the District's procedures in the SWMM. Application of PDP2 to the updated 1992 Plan model results in peak flow rates in excess of those expected based on rainfall and measured stream flows. In other words, updating the model from the 1992 Plan model using SWMM voids the calibration performed as part of the 1992 Plan and would not provide a model that could be calibrated using storm data that has been collected since 1992. This conclusion led to the decision to create a new hydrology model and to calibrate it using a substantial set of rainfall and runoff data that was not available in 1992. The new hydrology model is also based on more accurate topographic data than was available in 1992. In addition to the new hydrology model using the USACE programs HEC-1 and HEC-HMS, the new modeling system includes an unsteady-state hydraulic model (HEC-RAS) for the lower two-thirds of the watershed that is a key tool necessary to accurately determine potential project benefits. The new hydrology model and unsteady-state hydraulic model together are the new modeling system that forms the basis for this Plan Update.

The following sections describe the general process used to create the updated modeling system with additional detail provided in referenced appendices.

### 3.1.1 Key Locations for Summary Comparisons

To simplify data review, only a sampling of the data produced by the models is presented in the main body of this Plan Update. Peak flow rates for the 100-year event at key locations of interest are presented in tables in Sections 3 and 4, while additional data is included in appendices. All of the final work product models and results have been provided to the District on an external hard drive. Recommendations for key locations of interest were requested from local agencies and District staff. The key locations were selected because of known flooding issues or because local agencies use the point as a basis for flood impact evaluation purposes. These locations are the 26 locations listed on the summary tables included in the main body of this report. (Comparisons based on Point No. 23, located on Dry Creek downstream from its confluence with Linda Creek, are complicated by split flow conditions with flows diverting across Riverside Avenue that are not included in the Plan Update Point No. 23 flow rate values. Comparisons at Point No. 76 are similarly complicated by split flow conditions near Champion Oaks Drive.) The 1992 point numbering scheme has been carried forward into this project, and new points added during this study have been given point numbers greater than 1000. Point Numbers are identified on the watershed maps included in Appendix B.

## 3.2 UPDATE OF THE 1992 PLAN MODEL TO CURRENT DISTRICT METHODOLOGY

The first step of the hydrologic analyses performed for this Plan Update was to adapt the 1992 Plan HEC-1 model to methodologies consistent with current SWMM procedures. This adaptation included:

1. Replacing the rainfall distribution that was applied in the 1992 Plan model with a distribution based on the SWMM, and

2. Replacing the sub-watershed rainfall to runoff transformation method from Snyder unit hydrograph with kinematic wave.

The adapted model was run with a storm centering similar to that used in the 1992 Plan which generated the peak flow rates at Vernon Street. The adapted model results were compared at key locations to the results from the 1992 Plan model. This comparison (both models were based on Future Unmitigated conditions) is provided in Table 3.

The results of the comparison indicate that the adapted model produces slightly higher flows at Vernon Street. Wider variations at other locations are due to differences in storm centering. The storm centering for the 1992 Plan was based on calibration to actual events (February 1986 and March 1989) while the adapted model used SWMM based centering. Plate 12 illustrates the differences in precipitation between the 100-year event used in the 1992 Plan to model peak flows at Vernon Street and the 100-year SWMM based centering used to calculate peak flows at Vernon Street with the adapted model. Based on a detailed review of the timing of runoff indicated in the adapted model results, it was determined that adapting the 1992 Plan model to SWMM requirements would not result in reasonably calibrated results. Therefore, it was concluded that a new hydrology model would be necessary to achieve calibrated results with a HEC-1 model developed generally according to the requirements of the SWMM.

## Table 3: Peak Flow (cfs) Comparison of Original 1992 Plan Baseline Model to 1992 Plan Model Adapted to SWMM

| 2007 NODE | 1992 HEC-1 NODE | 1992 Study Point # | Description | Recurrence Interval: / Model Hydrology: / Model Geometry: | 100-year 1992 Adapted to SWMM Not Applicable | 100-year 1992 Plan Not Applicable | Difference cfs |
|---|---|---|---|---|---|---|---|
| **Miners Ravine** | | | | | | | |
| UR15K2 | MR15 | 207 | Dick Cook Road | | 2005 | 915 | 1090 |
| UR20P2 | MR20R | 205 | Moss Lane (Gages 1609/1610) | | 1746 | 1423 | 323 |
| YMR29I | MR29R | 202 | Cottonwood Lake | | 4029 | 2910 | 1119 |
| UR30H3 | MR30R | 197 | Joe Rodgers Area - Leibenger Lane | | 4210 | 3084 | 1126 |
| UMR40E | MR40R | 178 | Upstream of Confluence with Antelope Creek | | 9359 | 8864 | 495 |
| **Secret Ravine** | | | | | | | |
| YE50F2 | SE50R | 235 | Brace Road | | 3404 | 3038 | 366 |
| YSE51K | SE51R | 232 | Sierra College Blvd. | | 3641 | 3272 | 369 |
| USE52D | SE52R | 231 | China Gardens Near Rustic Hills/Rocklin Road (Gage 1618) | | 3725 | 3345 | 380 |
| YSE85Q | SE85R | 227 | Upstream of Confluence with Miners Ravine | | 4527 | 4422 | 105 |
| **Clover Valley** | | | | | | | |
| UCV10B | CV10R | 155 | Upstream of Confluence with Antelope Creek | | 961 | 724 | 237 |
| **Antelope Creek** | | | | | | | |
| YAC30B | AC30R | 140 | Sierra College Blvd. (Gage 1573) | | 2207 | 1986 | 221 |
| UC35G3 | AC35R | 134 | Upstream of Confluence with Clover Valley - Midas Avenue | | 2303 | 2093 | 210 |
| UC41E4 | AC41R | 126 | Antelope Creek Road - Downstream of SR-65 (Gage 1583) | | 3449 | 2963 | 486 |
| UDC4D | AC45R | 122 | Upstream of Confluence with Miners Ravine | | 3446 | 2970 | 476 |
| **Cirby Creek** | | | | | | | |
| YCC40C | CC40R | 51 | Coloma Way (Gage 1635) | | 900 | 912 | -12 |
| YCC45E | CCC5 | 49 | Upstream of Confluence with Linda Creek | | 935 | 948 | -13 |
| **Strap Ravine** | | | | | | | |
| UR20A4 | SR20R | 96 | Upstream of Confluence with Linda Creek @ McClaren (Gage 1611) | | 1214 | 972 | 242 |
| **Linda Creek** | | | | | | | |
| ULC5B | LCC1 | 92 | Troy Purdee Lane | | 940 | 775 | 165 |
| UC45J2 | LC45R | 82 | @ Sacramento County/Placer County Line | | 2042 | 1827 | 215 |
| ULC80I | LC80R | 76 | Champion Oaks/Sanoma Way (Gage 1626/1628) | | 2920 | 2788 | 132 |
| ULC95C | LC95R | 67 | Upstream of Confluence with Cirby Creek | | 3757 | 3629 | 128 |
| YCC45G | CC45R | 45 | Upstream of Confluence with Dry Creek | | 3965 | 3895 | 70 |
| **Dry Creek** | | | | | | | |
| UDC5B | DC5R | 26 | Royer Park | | 12323 | 11489 | 834 |
| YDCCC | RYCOMB | 23 | Confluence with Linda Creek/Cirby Creek | | 16141 | 15447 | 694 |
| YDC10D | VERNON | 21 | Vernon Street Crossing | | 15484 | 15051 | 433 |
| YDC71B | DCC11 | 9 | Sacramento County/Placer County Line | | 15568 | 15622 | -54 |

Flow comparison impacted by bypass, in channel discharge listed.

Additional details related to the model adaptation process are provided in Appendix F.

## 3.3 WATERSHED DELINEATION AND SUBDIVISION

The first step in developing a new hydrology model for this Plan Update was to delineate new watershed boundaries. The boundaries from the 1992 Plan were reviewed with IFSAR (Intermap) data and it was determined that some boundaries required significant revision. The new watershed delineations were primarily developed using Intermap data obtained for this purpose supplemented by other sources of information as described in Section 1.5.3. Watersheds were subdivided based on hydrologically significant boundaries, such as where portions of the watershed have different lengths of flow indicating different timing of runoff. Smaller sub-watersheds allow the Plan Update model to support evaluations on smaller tributaries, to quantify the impact of numerous surface lake storage features throughout the watershed, and to correctly reflect the runoff timing of different sub-stream areas within the 172 larger watersheds used in the 1992 Plan. The average watershed size in the Plan Update is approximately 100 acres. Ultimately, 1,288 sub-watersheds were delineated for the Plan Update. The new sub-watersheds use a naming convention that correlates to the 1992 Plan designations. Plate 13 illustrates the refinements made to the major watershed boundaries as a part of this Plan Update.

Concurrent with this Plan Update, an update of the hydrology for the adjacent Pleasant Grove Creek watershed was performed by the City of Roseville. The boundary between the Dry Creek and Pleasant Grove Creek watersheds was reconciled and used for the final analyses in both projects.

It was also observed that many canals passing through the Dry Creek watershed have a hydrologic impact on the location and routing of the tributaries with natural flow paths that cross the canals. Data was obtained from Placer County Water Agency regarding their canal system and its overflow discharge points which aided in establishing watershed boundaries.

Appendix B illustrates the watershed boundaries delineated for this Plan Update and the locations where boundaries were revised from the 1992 Plan.

## 3.4 LAND USE HYDROLOGIC FACTORS FOR 1992, 2007, AND GENERAL PLAN BUILD-OUT

### 3.4.1 Land Use

Land use provides key information about the amount and rate of runoff from each watershed. Impervious area is used to define that portion of the watershed from which the models assume all incident rainfall becomes runoff. Impervious area was also used to determine appropriate parameters for overland flow length and slope that impact watershed runoff response time. Land use was used to determine loss rates from the pervious portions of each watershed.

Plate 7, Plate 8 and Plate 9 show estimated land use types based on estimated 1992 (baseline), 2007 (current), and General Plan (build-out) conditions respectively. The baseline conditions were largely obtained from the 1992 Plan; however, some corrections were made to the drawing file sets provided from the 1992 Plan for areas of overlap and areas without data during the conversion to GIS file type. The build-out land use comes from the combined layers from the General Plans of the various City and County agencies within the watershed. Corrections were also made to this dataset as the data was combined from the various entities. The 2007 (current) conditions land use was derived from General Plan build-out land use, 2005 aerial imagery and other data as described in Section 1.5.4.

Table 4 summarizes the basic land use types (summarized from 480 classifications assigned to the source data) that were assigned for each of the scenarios. Appendix F provides detailed land use summary information for the baseline, current and build-out scenarios, respectively.

**Table 4: Land Use by Scenario**

| Land Use Code | Description | 1992 Areas (acres) | 2007 Areas (acres) | General Plan (acres) |
|---|---|---|---|---|
| OS | OPEN SPACE | 27,748 | 19,002 | 3,703 |
| AG | AGRICULTURAL | 1,297 | 1,516 | 2,463 |
| RR | RURAL RESIDENTIAL | 9,944 | 12,321 | 17,202 |
| RE | RURAL ESTATES | 8,229 | 8,397 | 10,986 |
| LDR | LOW DENSITY RESIDENTIAL | 8,868 | 13,117 | 16,191 |
| MDR | MEDIUM DENSITY RESIDENTIAL | 2,665 | 3,030 | 3,464 |
| HDR | HIGH DENSITY RESIDENTIAL | 441 | 529 | 604 |
| RES | RESERVE | 4 | 4 | 8 |
| REC | RECREATIONAL/PARKS | 452 | 600 | 2,013 |
| PQP | PUBLIC/QUASI PUBLIC | 408 | 598 | 886 |
| COMM | COMMERCIAL | 1,547 | 1,740 | 2,392 |
| IND | INDUSTRIAL | 1,575 | 1,725 | 2,301 |
| BP | BUSINESS PROFESSIONAL | 552 | 887 | 1,047 |
| ROAD | ROADWAYS | 1,136 | 1,416 | 1,598 |
| CITY | CITY UNKNOWN | 38 | 44 | 67 |
| | TOTAL | 64,903 | 64,924 | 64,924 |

Appendix F also provides a complete summary of the land use hydrologic factors used in preparing this Plan Update. The same factors were used for the baseline (1992), current (2007) and build-out scenarios.

### 3.4.2 Impervious Area

One key hydrologic factor derived directly from the land use is the percentage of impervious cover. Rainfall landing on impervious surfaces is generally assumed to runoff directly into the gutters and storm drain systems, thereby discharging into the streams without an opportunity for infiltration, evapotranspiration or local storage to occur. Generally, certain types of land use will have similar amounts of impervious cover no matter where they are built. However, in some cases, the impervious cover for similar land uses can vary due to local agency requirements.

To determine appropriate percentages of impervious cover by land use for the Plan Update, several documented and published rates were researched and tested in the calibration events. Most notably, the imperviousness rates documented in the SWMM and the DCWCRMP were used. Some adjustments were made based on the final calibrations of the model. The final rates used in the analysis are indicated in Appendix F for all 480 land use types applied in the Plan Update. Plate 4, Plate 5 and Plate 6 illustrate the imperviousness within the Dry Creek watershed for the 1992 baseline, current (2007) and build-out conditions, respectively.

### 3.4.3 Loss Rates

A second key hydrologic factor derived from the land use and the hydrologic soils types is the constant infiltration rate. The hydrologic soils types are shown on Plate 3. Generally, similar types of land use will have similar types of landscaping. While each project may have different landscaping, the assumed factors are for typical conditions and will balance out over the watershed. The constant infiltration rate applies to the non-impervious areas only and indicates the estimated combined effect of all constant losses, such as infiltration and evapotranspiration. Infiltration is the main component, which is why this factor is dependent on the hydrologic soil group. Development does not usually degrade this factor to a lesser value. In fact, in a number of cases, development may change this factor to a larger value, such as in the conversion of grasslands to park, where the density of grass and tree vegetation is substantially increased, slowing down runoff rates and providing an increased opportunity for infiltration to occur.

The SWMM procedures account for rainfall losses in two forms: an initial loss and a constant loss rate. The initial loss (amount reported in inches and applied to all areas of the watershed) indicates an amount of rainfall which goes into the wetting and filling of shallow storage in the watershed. Generally, this amount of rainfall must occur before any runoff will begin. The constant loss rate (or constant infiltration rate) simulates the combined effects of infiltration and evapotranspiration in the watershed.

The SWMM specifies the use of an initial loss of 0.1 inches for flood studies. Historically, because of the widespread use of HEC-1, the methodology of “initial and constant” losses has been applied. However, for this Plan Update, it was found that the application of “deficit and constant” loss rates calibrated better (especially for smaller events) than the previously applied methodology. This methodology can be applied with the use of HEC-HMS, but is not available in HEC-1.

For “deficit and constant” losses, the constant loss rate is applied exactly the same as in the application of initial and constant loss rate methodology. The initial loss is replaced by factors for a total loss amount, an initial amount of the total loss which is occupied at the start of the event and a recovery rate. It was found that a total loss amount of 0.2 inches for urbanized areas, and 0.4 inches for non-urbanized areas worked best in the calibration events. To initiate each event with the 0.1 inches consistent with the SWMM requirements, 0.1 inches was specified for the initial deficit, meaning 0.3 inches was assumed to be full for non-urban areas, and 0.1 inches was assumed to be full for the urban areas. Because the calibration events went for long periods of time, this methodology allowed for significant drying to occur between rainfall events, and more loss to occur in the initial rainfall of subsequent events, providing a better calibration.

A detailed discussion of the hydrologic calibration procedures used in this Plan Update is included in Appendix C.

### 3.4.4 Response Time Factors

For this Plan Update, a significant amount of effort was expended calibrating hydrologic parameters according to SWMM procedures. Initially, overland response factors (slope and length) were determined for every watershed in the updated models, based on the Intermap topography. Based on several early calibration tests, it was concluded that application of measured response factors significantly under-estimates the response time for the non-urban areas and results in peak hydrograph timing several hours in advance of stream gage data.

It was ultimately discovered that setting values for the slope and length overland response factors based solely on watershed imperviousness, and not actual slope and length, provided better overall model calibration, with timing of the peaks of recorded flooding closely matching model predictions. The relationships between imperviousness and the slope and length used to determine overland flow response time in the calibrated models are provided in Appendix F.

## 3.5 CHANNEL ROUTING

Routing of runoff through the channels in the hydrology model can be performed using various methods, including Muskingham-Cunge, kinematic wave routing, and Modified Puls routing. Muskingham-Cunge and kinematic wave routing are limited to a simplified cross section per reach. The Modified Puls routing method uses a storage-discharge relationship for each reach. Storage-discharge relationships can be developed using steady-state hydraulic modeling in HEC-RAS for a range of discharges. Routing of runoff in HEC-1 and HEC-HMS does not account for situations where varying tailwater conditions can result in multiple water surface elevations at the same discharge.

A more accurate method to perform channel routing is to use an unsteady-state hydraulic model that can account for situations where a single storage-discharge relationship does not adequately represent actual conditions. These situations commonly occur at structures such as bridges and confluences, and are even more pronounced in off-channel storage configurations such as the Miners Ravine Off-

Channel Detention Basin. It was therefore determined that an unsteady-state hydraulic routing model would be required to evaluate current conditions and potential future projects.

### 3.5.1 Channel Routing in the Hydrology Models

It was found that Modified Puls routing factors more closely represented the measured runoff response characteristics than the Muskingham-Cunge and kinematic wave routing options developed in the base models. A steady-state hydraulic model was developed using the Intermap topography for the significant upper reaches of the watersheds not covered by the main hydraulic routing model. Modified Puls routing parameters were developed from both the Intermap-based upper watershed model (developed specifically to provide channel routing parameters for the hydrology model) and a steady-state version the composite hydraulic model developed for the lower watershed. These parameters were used in the hydrology model for the most significant routing features. Including Modified Puls routing parameters for the reaches in the lower watershed covered by the unsteady-state hydraulic model allows the HEC-HMS simulation to provide reasonable results in many locations, but the results are significantly different from the unsteady HEC-RAS model in some key locations.

### 3.5.2 Unsteady-State Hydraulic Routing Model

Unsteady-state hydraulic models of the streams in the lower two-thirds of the Dry Creek watershed were used as the primary means of performing flow routing in the area it covers. Models were created to simulate 1992 and 2007 conditions and to model potential regional flood control projects. One HEC-RAS model was prepared with 2006 conditions to assess the effectiveness of the Miners Ravine Off-Channel Detention Basin project using the Plan Update models. Also, a 2010 model was prepared that included recent modifications to the Sierra College Boulevard culvert at Secret Ravine to provide an appropriate baseline for evaluating potential future projects. The 1992 condition composite unsteady-state HEC-RAS model of the Dry Creek watershed was developed using the sources of cross section and reach information listed in Table 5.

**Table 5: Composite Unsteady-State HEC-RAS Model Data Sources**

| River | Reach | Data Sources |
|---|---|---|
| Antelope Creek | AntelopeBlwClove | PWA FIS above 10725.49 (old 320), Allnew Composite[30] |
| Antelope Creek | Reach 1 | PWA FIS |
| Cirby Creek | Above Linda | PWA FIS previously converted with adjustments made for City of Roseville study by RBF |
| Cirby Creek | Below Linda | Allnew Composite |
| Clover Valley | Clover Valley 1 | PWA FIS |
| Dry Creek | Above Cirby | Allnew Composite modified by RBF for City of Roseville redevelopment studies |
| Dry Creek | Below Cirby | Allnew Composite and Placer Vineyards models |
| False Ravine | Reach 1 | Allnew Composite |
| Linda Creek | Above S Branch | Nolte Restudy 2004 |
| Linda Creek | South Branch | Nolte Restudy 2004 |
| Linda Creek | Below S Branch | Nolte Restudy 2004 revised by RBF based on Champion Oaks study for City of Roseville |
| Linda Creek | Below Strap | PWA FIS |
| Miners Ravine | Below Secret | Allnew Composite |
| Miners Ravine | Above False | PWA FIS above 13180.5 (old 308), 14146.17 to 18310.19 new model from RBF Miners Ravine and Sierra College Blvd evaluations |
| Miners Ravine | Bet Secret-False | Allnew Composite |
| Secret Ravine | Below Sucker | PWA FIS above 6488.499 (old 260), Allnew Composite below |
| Secret Ravine | Reach 1 | PWA FIS |
| Strap Ravine | Reach 1 | Allnew Composite |
| Sucker Ravine | Reach 1 | PWA FIS |

Each of the reaches was imported into HEC-RAS. Bridge definitions, where applicable, were adjusted to match existing conditions as observed during field investigation. The cross sections and structures were adjusted as appropriate to achieve stable unsteady-state performance without significantly altering effective conveyance. Other changes in the model to achieve unsteady-state function included establishing HTab parameters at each structure, appropriate application of permanent ineffective flow areas, select use of pilot channels and interpolated cross sections at various intervals.

The baseline composite model was constructed to match the approximate 1992 conditions by removing flood control improvements that had been implemented to reflect conditions without the improvements realized since that time. Significant projects implemented since 1992 were added based on record drawings to create the 2007 conditions model.

Appropriately configured unsteady-state hydraulic models were used in the calibration process, determinations of 100-year discharges at key locations for impact analyses and project alternative evaluations. A steady-state version of the composite model was

[30] Spink (Stantec), Model Combination for City of Roseville, 2005.

used to determine storage versus discharge relationships for reach routing (Modified Puls parameters) in the hydrology models.

## 3.6 HYDROLOGIC COMPUTER MODEL CALIBRATIONS

The refined watershed and new sub-watershed delineations, plus new the channel routing tools, provide the basis for the Plan Update models. To ensure that the models will produce appropriate response to incident rainfall, the parameters that affect the amount and timing of runoff need to be adjusted to demonstrate that the model reproduces known conditions. Calibration of a model is the process used to ensure that the model predicts actual system behavior as closely as possible. In model calibration, known input data for a historical event is entered into the model, and the output from the model is compared with the known flood conditions. Parameters in the model are then adjusted until the model output matches historic data for the event.[31] Once a model is calibrated, application of rainfall of a know recurrence interval can be used to estimate the flood levels corresponding to the same interval, though one needs to verify that the rainfall duration and distribution is the critical set for that recurrence interval to generate the peak discharge at the location of concern.

Four historic floods were selected to be used in the calibration process based on the significance of the events and the availability of rainfall and stream gage records. The events used for calibration of the models were the January 1995 event, the December 1995 event, the January 1997 event, and the December 2005 event.

The details of the processes used to perform the calibration analysis are provided in Appendix C.

The results of the calibration process are a hydrologic modeling system that includes hydrology calculations performed using HEC-HMS and hydraulic routing calculations performed using unsteady-state HEC-RAS that has been thoroughly validated to be able to accurately transform rainfall to runoff within the Dry Creek watershed.

## 3.7 COMPARATIVE ANALYSIS SCHEME

The Plan Update compares scenarios of various hydrology models combined with various hydraulic models. These Scenarios were used to evaluate what has occurred since 1992 and the potential of future changes as determined to be appropriate, to identify appropriate flood impact mitigation measures and support associated funding plans. Land use conditions that were evaluated include: 1992 conditions; 2007 conditions, with and without local detention; and build-out conditions, with and without incorporation of Low Impact Development (LID) features. (LID features are simulated in the hydrology model by reducing the effective impervious area that would otherwise be

[31] James M. Montgomery, Dry Creek Watershed Flood Control Plan, 1992.

associated with the land use.) Hydraulic models were used to simulate 1992 conditions, 2006 conditions (pre-Miners Ravine), 2007 conditions including the Miners Ravine Off-Channel Detention Basin Project, 2010 conditions that reflect modifications to Sierra College Boulevard at Secret Ravine, and conditions with the potential projects identified in this Plan Update.

Table 6 identifies the scenarios used to perform the primary analyses used to prepare the Plan Update. Additional scenarios were used to evaluate the potential projects individually. The scenarios are identified with numbers one (1) through nine (9).

**Table 6: Model Scenario Matrix**

| | **Land Use & Hydrology** | | | | |
|---|---|---|---|---|---|
| **Hydraulic Model** | **1992** | **2007 w/o Detention** | **2007 w/ Local Detention** | **Build-out no LID** | **Build-out with LID** |
| **1992 Baseline** | (1) 1992 Corrected Original Baseline | (2) 2007 Runoff- 1992 System | (3) 2007 Runoff with Local Detention, 1992 System | X | X |
| **2006 (without Miners Ravine Project)** | X | X | (4) 2006 Pre-Miners Ravine with Local Detention | X | X |
| **2007 (with Miners Ravine Project)** | X | X | (5) 2007 Conditions | X | X |
| **2010 Updated Baseline** | X | X | (6) 2010 Updated Baseline | (7) Unmitigated Build-out | (8) Build-out w/ LID but no Projects |
| **2010 with potential projects** | X | X | X | X | (9) Build-out w/ LID & Projects |

Note: “X” = not modeled

1. The *1992 Corrected Original Baseline* scenario uses Plan Update model methodology to provide a consistent basis for evaluating what has occurred since the preparation of the 1992 Plan. It uses 1992 hydrology and 1992 hydraulic conditions. (All recurrence intervals were evaluated and presented in Appendix G)
2. The *2007 Runoff-1992 System* scenario uses 2007 hydrology and 1992 hydraulic conditions to simulate conditions that would have existed in 2007 without the implementation of any mitigation measures. (Only 100-year recurrence interval evaluated was evaluated)

3. The 2007 Runoff with Local Detention-1992 System scenario uses 2007 hydrology that includes routing parameters to approximate the function of local detention basins and 1992 hydraulic conditions to simulate conditions that would have existed in 2007 if the only changes to the watershed were development and local detention. (Only 100-year recurrence interval evaluated was evaluated)
4. The *2006 – Pre-Miners Ravine* scenario uses 2007 hydrology and 2006 hydraulic conditions to provide a basis for separately evaluating the effectiveness of local detention and other projects from the regional detention basin project. (Only 100-year recurrence interval evaluated was evaluated)
5. The *2007 Conditions* scenario uses 2007 hydrology and 2007 hydraulics to provide a baseline for evaluating changes that have occurred since completion of the Miners Ravine Off-channel Detention Basin Project. (Only 100-year recurrence interval evaluated was evaluated)
6. The 2010 Updated Baseline is the same as the 2007 Conditions scenario with the addition of the changes that have occurred to Sierra College Boulevard at Secret Ravine. (Only 100-year recurrence interval evaluated was evaluated)
7. The *Unmitigated Build-out* scenario (updated from 2010 baseline) uses build-out hydrology without LID features and 2010 hydraulic conditions to provide a basis for potential impacts if build-out were to occur without any new mitigation measures. (All recurrence intervals were evaluated and presented in Appendix G)
8. The *Build-out with LID but no Projects* scenario uses build-out hydrology with LID and 2010 hydraulic conditions to provide a basis for determining how much additional regional attenuation would be required in addition to inclusion of LID features. (All recurrence intervals were evaluated and presented in Appendix G)
9. The *Build-out with LID and Projects* scenario uses build-out hydrology with LID and hydraulic conditions that reflect 2010 conditions plus the five potential projects identified in this Plan Update. (All recurrence intervals were evaluated and presented in Appendix G)

Twelve different comparative evaluations where made to quantify current and potential impacts and mitigation using these nine scenarios. (Note that minor anomalies in the HEC-RAS unsteady-state modeling cause small changes of less than one-half percent of peak discharge to be indicated in the comparisons where none would be expected.) The comparisons that include potential projects and mitigation are described in Section 4.

**Table 7: Comparison Summary**

| Report Table No. | Scenario Comparison | Description | Purpose |
|---|---|---|---|
| Table 9 | N/A | Plan Update 1992 Baseline compared to 1992 Plan Baseline | Provide a reference for determining what portion of flow differences from the 1992 Plan are due to the new models |
| Table 10 | 2-1 | Development impacts from 1992 to 2007 without any mitigation | Provide background information that shows how development can increase and decrease peak flow rates (increases are due to accelerating added runoff volume ahead of the peak) |
| Table 11 | 3-2 | Impact of local detention through 2007 | Show that detention designed for local peak flow attenuation can cause negative impacts downstream |
| Table 12 | 3-1 | Net impact of develop and local detention through 2007 | Show the impact of development separately from the impact of system changes from 1992 to 2007 |
| Table 13 | 4-3 | Impact of Linda Creek Bypass and SPRR projects | Isolate the impacts of major physical changes to the system from impacts due to development |
| Table 14 | 5-4 | Benefit from Miners Ravine Detention Basin | Quantify the benefit of the Miners Ravine Basin consistent with the Plan Update analysis |
| Table 15 | 6-5 | Impact of modifications to Sierra College Blvd at Secret Ravine | Quantify the impact of a completed project to provide an appropriate baseline for moving forward |
| Table 16 | 6-1 | Net impacts of development and system changes from 1992 through 2010 | Shows what impacts have not been mitigated from the time of initial plan development to the preparation of the Plan Update |
| Table 17 | 7-6 | Potential unmitigated impacts of future development | Provide a justification for requiring mitigation measures |
| Table 18 | N/A | Unmitigated build-out and regulatory flows | Lists unmitigated build-out, 1992 Plan Future and FEMA FIS flows at key locations |
| Table 22 | 8-7 | Potential benefit from LID | Estimate the expected benefit incorporating LID runoff reduction features compared to traditional development |
| Table 23 | 9-8 | Potential benefit from the identified projects | Quantify the benefit of the identified projects |
| Table 24 | 9-6 | Net impacts of potential future development and identified projects from 2010 through build-out | Shows what peak flow changes would be expected from a 2010 baseline through build-out with the project identified in the Plan Update |
| Table 25 | 9-1 | Net impacts of potential future development and identified projects from 1992 through build-out | Shows what peak flow changes would be expected from a 1992 baseline through build-out with the project identified in the Plan Update |

## 3.8 UPDATED 1992 BASELINE CONDITIONS MODELING IN HEC-HMS

Updated 1992 baseline peak flows were calculated to provide an appropriate baseline for impact analysis. Design rainfall events based on procedures in the SWMM were applied to the new calibrated hydrologic models (HEC-1 and HEC-HMS) to compute runoff from 2-, 10-, 25-, 50-, 100-, 200- and 500-year recurrence interval storm events. The SWMM storm centering approach was used to determine peak flow conditions at key locations as described in the following section. The outflow hydrographs from HEC-HMS were applied to the HEC-RAS model that represents 1992 conditions to complete the updated 1992 baseline conditions modeling. The updated 1992 baseline condition is referred to as scenario 1 in this study.

### 3.8.1 Storm Centering Analysis for Key Locations of Interest (HEC-1)

Application of SWMM requires determination of what cloudburst centering location and angle combination would result in peak discharge conditions for each location of concern. By using automated capabilities of the DCDESKTOP, storm centering analyses was performed using HEC-1 for the 100-year event with 0, 30, 60, and 90 degree storm angles at all sub-watershed locations within the Plan Update models. The full set of cloudburst center and angle analyses were run with the 1992 baseline HEC-1 model.

The results of the centering analysis were compared for all of the approximately 3,800 nodes in the analysis, but special attention was paid to the key locations. It was found that the following seven storm centering locations and storm angles (refer to Table 8) produce the peak flows, or nearly (within a few percent) the peak flows, for every key location in the watershed. Plate 14 illustrates where the seven centerings control the key peak flow rates.

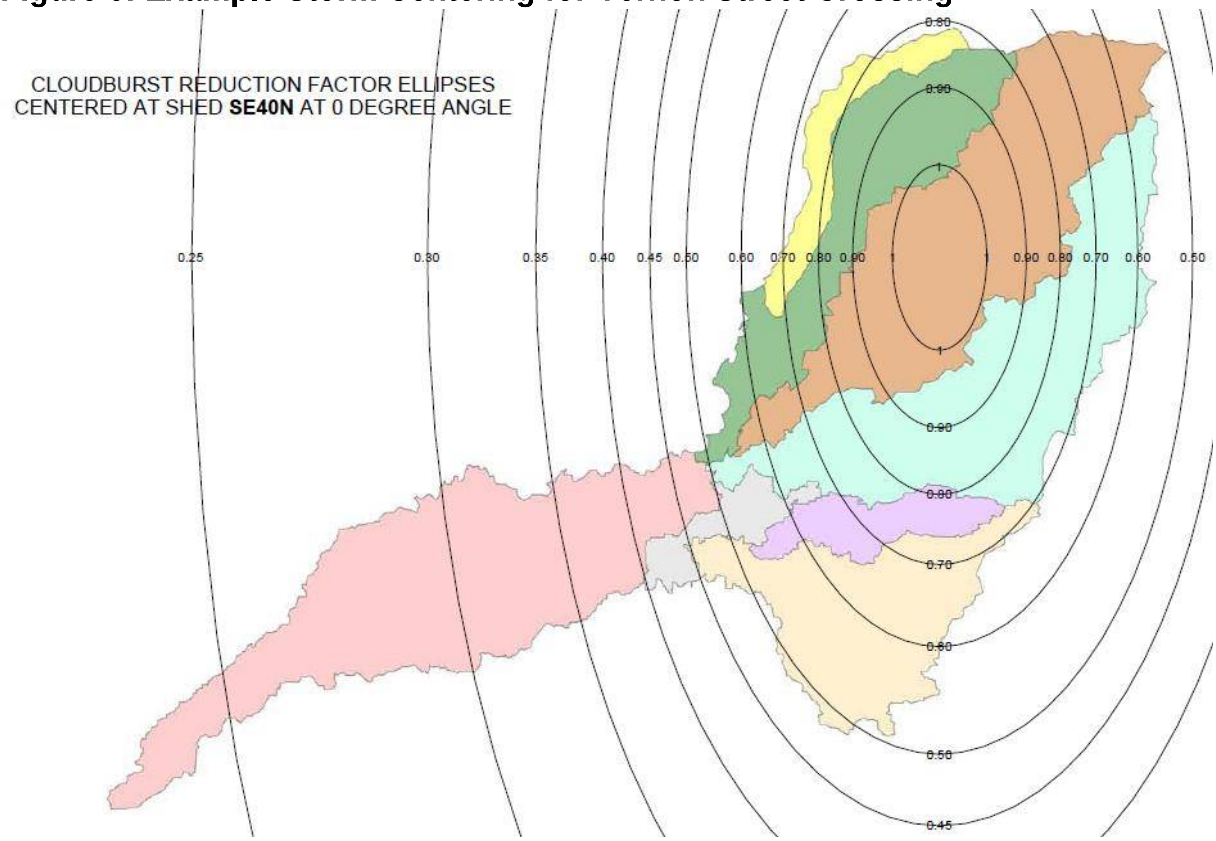
**Table 8: Summary of Storm Centering Locations and Angles**

| Watershed Center Location | In Watershed | Storm Angle |
|---|---|---|
| LC5A | Linda Creek | 0 |
| SE40N | Secret Ravine | 0 |
| LC40L | Linda Creek | 30 |
| MR15J | Miners Ravine | 30 |
| SE40M | Secret Ravine | 30 |
| AC5I | Antelope Creek | 60 |
| CC5G | Cirby Creek | 90 |

These seven centering location and angle combinations are used in this Plan Update to evaluate project alternatives and impacts at key locations throughout the watershed.

Figure 6 illustrates the storm centering adjustment ellipses with adjustment factors for the peak 1-hour precipitation of the event.

**Figure 6: Example Storm Centering for Vernon Street Crossing**




Storm centering and cloudburst reduction factor adjustments for all seven events are shown on Plates 15 through 21.

Watershed outflow hydrographs from HEC-HMS based on the seven centerings were linked to the *1992 Baseline* hydraulic routing model and run to generate *1992 Corrected Original Baseline* flow conditions (Scenario 1).

A comparison of the baseline peak flow rates between the 1992 Plan and this Plan Update at key locations for the 100-year event is shown in Table 9 to illustrate the differences between the 1992 Plan and Plan Update model results.

## 3.9 CURRENT CONDITIONS MODELING

A number of factors need to be considered to evaluate the hydrologic changes to the Dry Creek watershed that have occurred between 1992 and 2010. These include:

1. The added impervious area due to development and associated reduction in times of concentration,
2. The local detention that has been constructed to mitigate for development impacts, and

3. Hydrologically significant changes to the drainage system.

Hydrologically significant changes to the drainage system include the Linda Creek bypass systems, improvements to the Southern Pacific Railroad crossing of Dry Creek and the Miners Ravine Off-channel Detention Basin. These factors were evaluated both individually and cumulatively to assess the causes and effects of changes to the watershed on runoff from the watershed.

Current conditions modeling was developed by starting with the *1992 Corrected Original Baseline* models and making changes to the HEC-HMS models simulate development and local detention and the HEC-RAS models to simulate the impacts of regional projects. First, development that has occurred between 1992 and 2007 was simulated without local detention basins to determine what the impact of development would have been without local detention. Second, local detention was added to the HEC-HMS models to calculate its effects and the net impact of development. After the hydrologic changes from development were calculated, changes to the 1992 Baseline HEC-RAS model were made to evaluate changes that had occurred prior to construction of the Miners Ravine Off-channel Detention Project in 2006 and after its completion in 2007. Current conditions modeling was completed by modifying the HEC-RAS model to simulate improvements to Sierra College Boulevard at Secret Ravine thereby providing a *2010 Updated Baseline* for the evaluation of potential future changes to watershed hydrology and the physical drainage system.

### 3.9.1 Current Condition HEC-HMS Modeling

Hydrologic parameters for the Plan Update current condition HEC-HMS models were estimated from land use as described in Section 1.5.4 and shown on Plate 8. Land use summary tables for the 2007 baseline conditions are provided in Appendix F. Impervious area values were extracted from the data illustrated on Plate 5.

#### *3.9.1.1 Impact from Development from 1992 to 2007 without any Mitigation*

Watershed outflow hydrographs from HEC-HMS models that included development through 2007 without local detention were linked to the *1992 Baseline* hydraulic routing model and run to generate Scenario 2. Peak flow impacts from development from 1992 to 2007 are presented in Table 10 which compares Scenario 2 to Scenario 1. The results indicate some locations where flows increase and some locations where flows decrease. A review of the flow hydrographs indicates the increase in runoff volume from development, which has been largely concentrated in the lower portion of the watershed, flowing out ahead of runoff from undeveloped areas. The net result actually indicates that unmitigated development, though causing approximately a four percent increase in 100-year runoff volume would have caused essentially no change in peak runoff at Vernon Street (the results indicate a 0.06 percent decrease).

#### *3.9.1.2 Impact of Local Detention from 1992 through 2007*

Details of the various detention basins that were identified in the Plan Update process are included in Appendix I.

Within HEC-HMS, Modified Puls routing tables were added downstream of each watershed affected by a detention basins to approximate the impacts of the detention facilities.

Watershed outflow hydrographs from HEC-HMS models that included development through 2007 with local detention were linked to the *1992 Baseline* hydraulic routing model and run to generate Scenario 3. Peak flow impacts of local detention from 1992 to 2007 are presented in Table 11 which compares Scenario 3 to Scenario 2. Consistent with the findings based on the comparison of Scenario 2 to Scenario 1, the results indicate that while local detention can provide some benefit, detaining increased runoff volume so that it discharges occur closer to the peak runoff from undeveloped areas can, in some cases, increase peak flows compared to an unmitigated condition. The net impact of development and local detention is presented in Table 12 which compares Scenario 3 to Scenario 1.

### 3.9.2 Hydraulic Routing for Pre-Miners Ravine – 2006 Conditions Evaluation

For the pre-Miners Ravine Off-channel Detention Basin (2006) conditions model, the 1992 hydraulic routing model was adjusted to include the following three projects of significance that were constructed between 1992 and 2006:

#### *3.9.2.1 Southern Pacific Railroad Bridge*

The 1992 Baseline HEC-RAS model was modified to reflect Southern Pacific Railroad Bridge project. In the 1992 model, the crossing was represented by four elliptical culverts, each with a span of 12.5 feet and a rise of 17.5 feet, and two box culverts, one with a span of 12 feet and a rise of 16 feet and the other with a span of 23 feet and a rise of 14 feet. The current conditions HEC-RAS model replaced the culverts with a bridge that spans approximately 100 feet with a low nearly 20 feet above the channel bed.

#### *3.9.2.2 Linda Creek Bypass Channel*

The 1992 Baseline HEC-RAS model was modified to reflect the Linda Creek Bypass Channel project by modifying cross sections on Linda Creek below Strap Ravine. Based on the construction plans for the project, a trapezoidal channel was added to cross section 9541.7 and sections downstream from it. The bypass channel has a bottom width of about 25 feet, side slopes of about three horizontal to one vertical and a depth of about 4 feet.

#### *3.9.2.3 Linda Creek Bypass Piping*

The 1992 Baseline HEC-RAS model was modified to reflect the Linda Creek Bypass Piping by adding a lateral weir at River Station 3019.3 on the “Below Strap” reach on Linda Creek. The points on the channel bottom were lowered according to the construction drawings for the project. Two parallel, nine-foot diameter circular culverts, 860 feet in length, were connected from the lateral weir to River Station 1235.899 downstream on Linda Creek, in the same reach.

Watershed outflow hydrographs from HEC-HMS models that included development through 2007 with local detention were linked to the 2006 hydraulic routing model and run to generate Scenario 4. Peak flow impacts of the Linda Creek Bypass and Southern Pacific Railroad projects are presented in Table 13 which compares Scenario 4 to Scenario 3. The analysis performed for this Plan Update indicates that these projects caused a three percent increase in the 100-year peak discharge at Vernon Street.

### 3.9.3 Miners Ravine Off-channel Detention Basin – 2007 Conditions Evaluation

The site of the Miners Ravine Off-channel Detention Basin included the remnant basins from a historic sewage treatment plan from 1992 until 2006. The 1992 Baseline HEC-RAS model included the features as these existing prior to construction of the detention basin as two storage basins with appropriate capacity curves and interconnects between the stream and the basins and between the basins. For the 2007 model to reflect the construction of the detention basin, the capacity curves were replaced with post-construction capacity curves based on record drawings. An additional small storage area was included upstream, east of Sierra College Boulevard, to simulate the inlet structure with a weir and flap gates to connect the upstream structure to the stream and a culvert to connect it to the new detention basin. The Sierra College Boulevard culvert size was revised to match extended culverts with fish passage enhancements. The spillway of the detention facility was added as a storage area connection to the downstream storage area. The lateral weirs connecting the channel to the detention basin were also adjusted to reflect the post-construction embankment elevation.

Watershed outflow hydrographs from HEC-HMS models that included development through 2007 with local detention were linked to the 2007 hydraulic routing model and run to generate Scenario 5. The peak flow attenuation benefit of the Miners Ravine Off-Channel Detention Basin is presented in Table 14 which compares Scenario 5 to Scenario 4. The analysis performed for this Plan Update indicates that basin provides slightly less that 100 cfs of peak flow reduction at Vernon Street. The *Miners Ravine Off-Channel Detention Basin Hydrology & Hydraulic Design Report* indicated an expected benefit of a 263 cfs flow reduction at Vernon Street. This Plan Update indicates a lower 100-year benefit value than what had been expected because the 100-year peak discharge on Miners Ravine at the project site is significantly lower based on the Plan Update models (2,480 cfs) as compared to what was used for basin design (3,788 cfs). The detention basin can be expected to provide greater benefit in an event with a peak discharge close to what had been used during design.

Though Sierra College Boulevard overtopped in 1995 with at an estimated discharge in excess of 4,000 cfs, precipitation records indicate that this storm may have been more severe that a 200-year event on Miners Ravine. The Plan Update analysis indicates a 2007 baseline condition 100-year discharge of 2,480 cfs. The lower flow rates are primarily due to the routing parameters used in the new model that were based on an extensive calibration process. Because the Plan Update flow rates are lower than the design flow rate, the indicated benefit is lower than that identified in the project design process.

### 3.9.4 Sierra College Boulevard at Secret Ravine – 2010 Conditions Evaluation

The 2007 conditions HEC-RAS model was revised to reflect modification to the Sierra College Boulevard crossing of Secret Ravine. The only change that was modeled was to change the profile of the road which changes the roadway overtopping condition. It was necessary to model this detail to provide a baseline for future project evaluation because one of the potential project locations is on Secret Ravine just upstream from Sierra College Boulevard and the roadway modifications impact how the potential project would function.

Watershed outflow hydrographs from HEC-HMS models that included development through 2007 with local detention were linked to the 2010 hydraulic routing model and run to generate Scenario 6. The peak flow impacts of the improvements made to Sierra College Boulevard at Secret Ravine are presented in Table 15 which compares Scenario 6 to Scenario 5. The net peak flow impacts from 1992 thought 2010 are presented in Table 16 which compares Scenario 6 to Scenario 1.

## 3.10 GENERAL PLAN BUILD-OUT MODELING

The projected General Plan land use data sets from various planning agencies within the watershed were assembled as shown in Plate 9. Build-out imperviousness is illustrated on Plate 6. Land use summary tables for the general plan build-out condition are provided in Appendix F.

Hydrology models were prepared and run for two different future condition evaluations, one with and one without LID features expected to be required in new development. The model without LID was used to evaluate Future Unmitigated conditions and the model with LID was used to evaluate the benefit of LID and was used to perform project evaluations.

### 3.10.1 General Plan with Current Mitigation

Watershed outflow hydrographs from HEC-HMS models that included general plan build-out but not LID were linked to the 2010 Updated Baseline hydraulic routing model and run to generate Scenario 7. This model represents the expected build-out flows that would results if no additional mitigation were placed in the watershed. The potential unmitigated peak flow impacts of future development are presented in Table 17 which compares Scenario 7 to Scenario 6. The potential impacts of future development on peak discharges are much greater than the impacts from development that occurred prior to 2007 because of the location of the future development being higher in the watershed which would result in the increase in runoff volume discharging closer to the overall peak instead of before it.

### 3.10.2 General Plan with LID

It is anticipated that LID features will be required of all significant new development. Because LID features are considered to be mitigation measures, the detailed LID discussion is provided in Section 4.5.4.

### 3.10.3 Future Fully Developed Unmitigated Other Regulatory Flows

It is expected that the District will require that the Future Unmitigated results be used for floodplain evaluations, though additional requirements may also apply. For comparison, Table 18 lists the values from the 1992 Plan which have been used for District evaluations and the effective Flood Insurance Study (FIS) used for FEMA regulatory issues. The District should be consulted to verify that appropriate discharge rates and floodplain elevations are selected for any project evaluation.

## 3.11 PEAK FLOW TABLES FOR VARIOUS RECURRENCE INTERVALS

Tables of peak flows for the 500-year, 200-year, 100-year, 50-year, 25-year, 10-year and 2-year events, for the selected modeled scenarios are included in Appendix G. The scenarios for which the full spectrum of recurrence interval has been included are:

1. Scenario 1, the 1992 Corrected Original Baseline to provide a consistent base for quantifying impacts from the time of the 1992 Plan,
2. Scenario 6, 2010 Updated Baseline conditions to provide a consistent base for quantifying impacts from the time of this Plan Update,
3. Scenario 7, Unmitigated Build-out conditions to provide maximum flow conditions, and
4. Scenario 9, Build-out with LID and all identified projects to provide an estimate of the likely maximum feasible mitigation.

Scenarios 5 and 8 have also been fully calculated and delivered with the project digital files. Scenario 5 provides a 2007 baseline and Scenario 8 provides the LID evaluation.

## Table 9: Peak Flow (cfs) Comparison of Plan Update Baseline to Original 1992 Plan Baseline

| 2007 NODE | 1992 HEC-1 NODE | 1992 Study Point # | Description | Recurrence Interval: / Model Hydrology: / Model Geometry: | 100-year 1992 Baseline Inflows 1992 Baseline System | 100-year 1992 Plan Baseline Not Applicable | Difference cfs |
|---|---|---|---|---|---|---|---|
| **Miners Ravine** | | | | Scenario: | 1 | 1992 Plan 1992 | |
| UR15K2 | MR15 | 207 | Dick Cook Road | | 1714 | 1684 | 30 |
| UR20P2 | MR20R | 205 | Moss Lane (Gages 1609/1610) | | 1899 | 2468 | -569 |
| YMR29I | MR29R | 202 | Cottonwood Lake | | 2402 | 2680 | -278 |
| UR30H3 | MR30R | 197 | Joe Rodgers Area - Leibenger Lane | | 2268 | 2881 | -613 |
| UMR40E | MR40R | 178 | Upstream of Confluence with Antelope Creek | | 7427 | 7844 | -417 |
| **Secret Ravine** | | | | | | | |
| YE50F2 | SE50R | 235 | Brace Road | | 4219 | 3090 | 1129 |
| YSE51K | SE51R | 232 | Sierra College Blvd. | | 4681 | 3375 | 1306 |
| USE52D | SE52R | 231 | China Gardens Near Rustic Hills/Rocklin Road (Gage 1618) | | 4679 | 3374 | 1305 |
| YSE85Q | SE85R | 227 | Upstream of Confluence with Miners Ravine | | 5447 | 4197 | 1250 |
| **Clover Valley** | | | | | | | |
| UCV10B | CV10R | 155 | Upstream of Confluence with Antelope Creek | | 987 | 857 | 130 |
| **Antelope Creek** | | | | | | | |
| YAC30B | AC30R | 140 | Sierra College Blvd. (Gage 1573) | | 2819 | 2180 | 639 |
| UC35G3 | AC35R | 134 | Upstream of Confluence with Clover Valley - Midas Avenue | | 2982 | 2330 | 652 |
| UC41E4 | AC41R | 126 | Antelope Creek Road - Downstream of SR-65 (Gage 1583) | | 3630 | 3086 | 544 |
| UDC4D | AC45R | 122 | Upstream of Confluence with Miners Ravine | | 3605 | 3075 | 530 |
| **Cirby Creek** | | | | | | | |
| YCC40C | CC40R | 51 | Coloma Way (Gage 1635) | | 758 | 842 | -84 |
| YCC45E | CCC5 | 49 | Upstream of Confluence with Linda Creek | | 3096 | 4113 | -1017 |
| **Strap Ravine** | | | | | | | |
| UR20A4 | SR20R | 96 | Upstream of Confluence with Linda Creek @ McClaren (Gage 1611) | | 919 | 920 | -1 |
| **Linda Creek** | | | | | | | |
| ULC5B | LCC1 | 92 | Troy Purdee Lane | | 545 | 473 | 72 |
| UC45J2 | LC45R | 82 | @ Sacramento County/Placer County Line | | 2044 | 2489 | -445 |
| ULC80I | LC80R | 76 | Champion Oaks/Sanoma Way (Gage 1626/1628) | | 2158 | 3297 | -1139 |
| ULC95C | LC95R | 67 | Upstream of Confluence with Cirby Creek | | 2682 | 3972 | -1290 |
| YCC45G | CC45R | 45 | Upstream of Confluence with Dry Creek | | 3024 | 4126 | -1102 |
| **Dry Creek** | | | | | | | |
| UDC5B | DC5R | 26 | Royer Park | | 10663 | 10476 | 187 |
| YDCCC | RYCOMB | 23 | Confluence with Linda Creek/Cirby Creek | | 8582 | 13825 | -5243 |
| YDC10D | VERNON | 21 | Vernon Street Crossing | | 12635 | 13706 | -1071 |
| YDC71B | DCC11 | 9 | Sacramento County/Placer County Line | | 12571 | 14048 | -1477 |

Flow comparison impacted by bypass, in channel discharge listed.

## Table 10: Peak Flow (cfs) Impacts from Development from 1992 to 2007 without any Mitigation

| 2007 NODE | 1992 HEC-1 NODE | 1992 Study Point # | Description | Recurrence Interval: / Model Hydrology: / Model Geometry: | 100-year 2007 Undetained Inflows 1992 Baseline System | 100-year 1992 Baseline Inflows 1992 Baseline System | Difference cfs |
|---|---|---|---|---|---|---|---|
| **Miners Ravine** | | | | Scenario: | 2 | 1 | |
| UR15K2 | MR15 | 207 | Dick Cook Road | | 1732 | 1714 | 18 |
| UR20P2 | MR20R | 205 | Moss Lane (Gages 1609/1610) | | 1919 | 1899 | 20 |
| YMR29I | MR29R | 202 | Cottonwood Lake | | 2376 | 2402 | -26 |
| UR30H3 | MR30R | 197 | Joe Rodgers Area - Leibenger Lane | | 2285 | 2268 | 17 |
| UMR40E | MR40R | 178 | Upstream of Confluence with Antelope Creek | | 7260 | 7427 | -167 |
| **Secret Ravine** | | | | | | | |
| YE50F2 | SE50R | 235 | Brace Road | | 4286 | 4219 | 67 |
| YSE51K | SE51R | 232 | Sierra College Blvd. | | 4688 | 4681 | 7 |
| USE52D | SE52R | 231 | China Gardens Near Rustic Hills/Rocklin Road (Gage 1618) | | 4642 | 4679 | -37 |
| YSE85Q | SE85R | 227 | Upstream of Confluence with Miners Ravine | | 5412 | 5447 | -35 |
| **Clover Valley** | | | | | | | |
| UCV10B | CV10R | 155 | Upstream of Confluence with Antelope Creek | | 957 | 987 | -30 |
| **Antelope Creek** | | | | | | | |
| YAC30B | AC30R | 140 | Sierra College Blvd. (Gage 1573) | | 2834 | 2819 | 15 |
| UC35G3 | AC35R | 134 | Upstream of Confluence with Clover Valley - Midas Avenue | | 2989 | 2982 | 7 |
| UC41E4 | AC41R | 126 | Antelope Creek Road - Downstream of SR-65 (Gage 1583) | | 3611 | 3630 | -19 |
| UDC4D | AC45R | 122 | Upstream of Confluence with Miners Ravine | | 3581 | 3605 | -24 |
| **Cirby Creek** | | | | | | | |
| YCC40C | CC40R | 51 | Coloma Way (Gage 1635) | | 932 | 758 | 174 |
| YCC45E | CCC5 | 49 | Upstream of Confluence with Linda Creek | | 3243 | 3096 | 147 |
| **Strap Ravine** | | | | | | | |
| UR20A4 | SR20R | 96 | Upstream of Confluence with Linda Creek @ McClaren (Gage 1611) | | 1200 | 919 | 281 |
| **Linda Creek** | | | | | | | |
| ULC5B | LCC1 | 92 | Troy Purdee Lane | | 560 | 545 | 15 |
| UC45J2 | LC45R | 82 | @ Sacramento County/Placer County Line | | 2279 | 2044 | 235 |
| ULC80I | LC80R | 76 | Champion Oaks/Sanoma Way (Gage 1626/1628) | | 2202 | 2158 | 44 |
| ULC95C | LC95R | 67 | Upstream of Confluence with Cirby Creek | | 2721 | 2682 | 39 |
| YCC45G | CC45R | 45 | Upstream of Confluence with Dry Creek | | 3202 | 3024 | 178 |
| **Dry Creek** | | | | | | | |
| UDC5B | DC5R | 26 | Royer Park | | 10427 | 10663 | -236 |
| YDCCC | RYCOMB | 23 | Confluence with Linda Creek/Cirby Creek | | 8528 | 8582 | -54 |
| YDC10D | VERNON | 21 | Vernon Street Crossing | | 12627 | 12635 | -8 |
| YDC71B | DCC11 | 9 | Sacramento County/Placer County Line | | 12608 | 12571 | 37 |

Flow comparison impacted by bypass, in channel discharge listed.

## Table 11: Peak Flow (cfs) Impacts of Local Detention from 1992 through 2007

| 2007 NODE | 1992 HEC-1 NODE | 1992 Study Point # | Description | Recurrence Interval: / Model Hydrology: / Model Geometry: | 100-year 2007 Locally Detained Inflows 1992 Baseline System | 100-year 2007 Undetained Inflows 1992 Baseline System | Difference cfs |
|---|---|---|---|---|---|---|---|
| **Miners Ravine** | | | | Scenario: | 2 | 1 | 3 |
| UR15K2 | MR15 | 207 | Dick Cook Road | | 1729 | 1732 | -3 |
| UR20P2 | MR20R | 205 | Moss Lane (Gages 1609/1610) | | 1912 | 1919 | -7 |
| YMR29I | MR29R | 202 | Cottonwood Lake | | 2367 | 2376 | -9 |
| UR30H3 | MR30R | 197 | Joe Rodgers Area - Leibenger Lane | | 2275 | 2285 | -10 |
| UMR40E | MR40R | 178 | Upstream of Confluence with Antelope Creek | | 7288 | 7260 | 28 |
| **Secret Ravine** | | | | | | | |
| YE50F2 | SE50R | 235 | Brace Road | | 4286 | 4286 | 0 |
| YSE51K | SE51R | 232 | Sierra College Blvd. | | 4688 | 4688 | 0 |
| USE52D | SE52R | 231 | China Gardens Near Rustic Hills/Rocklin Road (Gage 1618) | | 4642 | 4642 | 0 |
| YSE85Q | SE85R | 227 | Upstream of Confluence with Miners Ravine | | 5431 | 5412 | 19 |
| **Clover Valley** | | | | | | | |
| UCV10B | CV10R | 155 | Upstream of Confluence with Antelope Creek | | 958 | 957 | 1 |
| **Antelope Creek** | | | | | | | |
| YAC30B | AC30R | 140 | Sierra College Blvd. (Gage 1573) | | 2834 | 2834 | 0 |
| UC35G3 | AC35R | 134 | Upstream of Confluence with Clover Valley - Midas Avenue | | 2989 | 2989 | 0 |
| UC41E4 | AC41R | 126 | Antelope Creek Road - Downstream of SR-65 (Gage 1583) | | 3610 | 3611 | -1 |
| UDC4D | AC45R | 122 | Upstream of Confluence with Miners Ravine | | 3581 | 3581 | 0 |
| **Cirby Creek** | | | | | | | |
| YCC40C | CC40R | 51 | Coloma Way (Gage 1635) | | 932 | 932 | 0 |
| YCC45E | CCC5 | 49 | Upstream of Confluence with Linda Creek | | 3237 | 3243 | -6 |
| **Strap Ravine** | | | | | | | |
| UR20A4 | SR20R | 96 | Upstream of Confluence with Linda Creek @ McClaren (Gage 1611) | | 1191 | 1200 | -9 |
| **Linda Creek** | | | | | | | |
| ULC5B | LCC1 | 92 | Troy Purdee Lane | | 560 | 560 | 0 |
| UC45J2 | LC45R | 82 | @ Sacramento County/Placer County Line | | 2279 | 2279 | 0 |
| ULC80I | LC80R | 76 | Champion Oaks/Sanoma Way (Gage 1626/1628) | | 2208 | 2202 | 6 |
| ULC95C | LC95R | 67 | Upstream of Confluence with Cirby Creek | | 2721 | 2721 | 0 |
| YCC45G | CC45R | 45 | Upstream of Confluence with Dry Creek | | 3191 | 3202 | -11 |
| **Dry Creek** | | | | | | | |
| UDC5B | DC5R | 26 | Royer Park | | 10458 | 10427 | 31 |
| YDCCC | RYCOMB | 23 | Confluence with Linda Creek/Cirby Creek | | 8534 | 8528 | 6 |
| YDC10D | VERNON | 21 | Vernon Street Crossing | | 12647 | 12627 | 20 |
| YDC71B | DCC11 | 9 | Sacramento County/Placer County Line | | 12638 | 12608 | 30 |

Flow comparison impacted by bypass, in channel discharge listed.

## Table 12: Peak Flow (cfs) Impacts of Development and Local Detention from 1992 through 2007

| 2007 NODE | 1992 HEC-1 NODE | 1992 Study Point # | Description | 100-year | 100-year | Difference |
|---|---|---|---|---|---|---|
| | | | Recurrence Interval: | 100-year | 100-year | Difference |
| | | | Model Hydrology: | 2007 Locally Detained Inflows | 1992 Baseline Inflows | |
| | | | Description / Model Geometry: | 1992 Baseline System | 1992 Baseline System | cfs |
| **Miners Ravine** | | | Scenario: | 3 | 1 | |
| UR15K2 | MR15 | 207 | Dick Cook Road | 1729 | 1714 | 15 |
| UR20P2 | MR20R | 205 | Moss Lane (Gages 1609/1610) | 1912 | 1899 | 13 |
| YMR29I | MR29R | 202 | Cottonwood Lake | 2367 | 2402 | -35 |
| UR30H3 | MR30R | 197 | Joe Rodgers Area - Leibenger Lane | 2275 | 2268 | 7 |
| UMR40E | MR40R | 178 | Upstream of Confluence with Antelope Creek | 7288 | 7427 | -139 |
| **Secret Ravine** | | | | | | |
| YE50F2 | SE50R | 235 | Brace Road | 4286 | 4219 | 67 |
| YSE51K | SE51R | 232 | Sierra College Blvd. | 4688 | 4681 | 7 |
| USE52D | SE52R | 231 | China Gardens Near Rustic Hills/Rocklin Road (Gage 1618) | 4642 | 4679 | -37 |
| YSE85Q | SE85R | 227 | Upstream of Confluence with Miners Ravine | 5431 | 5447 | -16 |
| **Clover Valley** | | | | | | |
| UCV10B | CV10R | 155 | Upstream of Confluence with Antelope Creek | 958 | 987 | -29 |
| **Antelope Creek** | | | | | | |
| YAC30B | AC30R | 140 | Sierra College Blvd. (Gage 1573) | 2834 | 2819 | 15 |
| UC35G3 | AC35R | 134 | Upstream of Confluence with Clover Valley - Midas Avenue | 2989 | 2982 | 7 |
| UC41E4 | AC41R | 126 | Antelope Creek Road - Downstream of SR-65 (Gage 1583) | 3610 | 3630 | -20 |
| UDC4D | AC45R | 122 | Upstream of Confluence with Miners Ravine | 3581 | 3605 | -24 |
| **Cirby Creek** | | | | | | |
| YCC40C | CC40R | 51 | Coloma Way (Gage 1635) | 932 | 758 | 174 |
| YCC45E | CCC5 | 49 | Upstream of Confluence with Linda Creek | 3237 | 3096 | 141 |
| **Strap Ravine** | | | | | | |
| UR20A4 | SR20R | 96 | Upstream of Confluence with Linda Creek @ McClaren (Gage 1611) | 1191 | 919 | 272 |
| **Linda Creek** | | | | | | |
| ULC5B | LCC1 | 92 | Troy Purdee Lane | 560 | 545 | 15 |
| UC45J2 | LC45R | 82 | @ Sacramento County/Placer County Line | 2279 | 2044 | 235 |
| ULC80I | LC80R | 76 | Champion Oaks/Sanoma Way (Gage 1626/1628) | 2208 | 2158 | 50 |
| ULC95C | LC95R | 67 | Upstream of Confluence with Cirby Creek | 2721 | 2682 | 39 |
| YCC45G | CC45R | 45 | Upstream of Confluence with Dry Creek | 3191 | 3024 | 167 |
| **Dry Creek** | | | | | | |
| UDC5B | DC5R | 26 | Royer Park | 10458 | 10663 | -205 |
| YDCCC | RYCOMB | 23 | Confluence with Linda Creek/Cirby Creek | 8534 | 8582 | -48 |
| YDC10D | VERNON | 21 | Vernon Street Crossing | 12647 | 12635 | 12 |
| YDC71B | DCC11 | 9 | Sacramento County/Placer County Line | 12638 | 12571 | 67 |

Flow comparison impacted by bypass, in channel discharge listed.

## Table 13: Peak Flow (cfs) Impacts of Linda Creek Bypass and Southern Pacific Railroad Projects

| 2007 NODE | 1992 HEC-1 NODE | 1992 Study Point # | Description | Recurrence Interval: / Model Hydrology: / Model Geometry: | 100-year / 2007 Locally Detained Inflows / 2006 System (no Miners) | 100-year / 2007 Locally Detained Inflows / 1992 Baseline System | Difference / cfs |
|---|---|---|---|---|---|---|---|
| **Miners Ravine** | | | | Scenario: | 4 | 3 | |
| UR15K2 | MR15 | 207 | Dick Cook Road | | 1728 | 1729 | -1 |
| UR20P2 | MR20R | 205 | Moss Lane (Gages 1609/1610) | | 1909 | 1912 | -3 |
| YMR29I | MR29R | 202 | Cottonwood Lake | | 2363 | 2367 | -4 |
| UR30H3 | MR30R | 197 | Joe Rodgers Area - Leibenger Lane | | 2272 | 2275 | -3 |
| UMR40E | MR40R | 178 | Upstream of Confluence with Antelope Creek | | 7288 | 7288 | 0 |
| **Secret Ravine** | | | | | | | |
| YE50F2 | SE50R | 235 | Brace Road | | 4287 | 4286 | 1 |
| YSE51K | SE51R | 232 | Sierra College Blvd. | | 4689 | 4688 | 1 |
| USE52D | SE52R | 231 | China Gardens Near Rustic Hills/Rocklin Road (Gage 1618) | | 4642 | 4642 | 0 |
| YSE85Q | SE85R | 227 | Upstream of Confluence with Miners Ravine | | 5432 | 5431 | 1 |
| **Clover Valley** | | | | | | | |
| UCV10B | CV10R | 155 | Upstream of Confluence with Antelope Creek | | 957 | 958 | -1 |
| **Antelope Creek** | | | | | | | |
| YAC30B | AC30R | 140 | Sierra College Blvd. (Gage 1573) | | 2834 | 2834 | 0 |
| UC35G3 | AC35R | 134 | Upstream of Confluence with Clover Valley - Midas Avenue | | 2989 | 2989 | 0 |
| UC41E4 | AC41R | 126 | Antelope Creek Road - Downstream of SR-65 (Gage 1583) | | 3608 | 3610 | -2 |
| UDC4D | AC45R | 122 | Upstream of Confluence with Miners Ravine | | 3577 | 3581 | -4 |
| **Cirby Creek** | | | | | | | |
| YCC40C | CC40R | 51 | Coloma Way (Gage 1635) | | 931 | 932 | -1 |
| YCC45E | CCC5 | 49 | Upstream of Confluence with Linda Creek | | 3259 | 3237 | 22 |
| **Strap Ravine** | | | | | | | |
| UR20A4 | SR20R | 96 | Upstream of Confluence with Linda Creek @ McClaren (Gage 1611) | | 1191 | 1191 | 0 |
| **Linda Creek** | | | | | | | |
| ULC5B | LCC1 | 92 | Troy Purdee Lane | | 559 | 560 | -1 |
| UC45J2 | LC45R | 82 | @ Sacramento County/Placer County Line | | 2330 | 2279 | 51 |
| ULC80I | LC80R | 76 | Champion Oaks/Sanoma Way (Gage 1626/1628) | | 2229 | 2208 | 21 |
| ULC95C | LC95R | 67 | Upstream of Confluence with Cirby Creek | | 2728 | 2721 | 7 |
| YCC45G | CC45R | 45 | Upstream of Confluence with Dry Creek | | 3223 | 3191 | 32 |
| **Dry Creek** | | | | | | | |
| UDC5B | DC5R | 26 | Royer Park | | 10454 | 10458 | -4 |
| YDCCC | RYCOMB | 23 | Confluence with Linda Creek/Cirby Creek | | 8755 | 8534 | 221 |
| YDC10D | VERNON | 21 | Vernon Street Crossing | | 13066 | 12647 | 419 |
| YDC71B | DCC11 | 9 | Sacramento County/Placer County Line | | 12679 | 12638 | 41 |

Flow comparison impacted by bypass, in channel discharge listed.

## Table 14: Peak Flow (cfs) Impacts of Miners Ravine Off-Channel Detention Facility

| 2007 NODE | 1992 HEC-1 NODE | 1992 Study Point # | Description / Recurrence Interval: / Model Hydrology: / Model Geometry: | 100-year 2007 Locally Detained Inflows 2007 System (w/ Miners) | 100-year 2007 Locally Detained Inflows 2006 System (no Miners) | Difference cfs |
|---|---|---|---|---|---|---|
| **Miners Ravine** | | | Scenario: | 5 | 4 | |
| UR15K2 | MR15 | 207 | Dick Cook Road | 1727 | 1728 | -1 |
| UR20P2 | MR20R | 205 | Moss Lane (Gages 1609/1610) | 1910 | 1909 | 1 |
| YMR29I | MR29R | 202 | Cottonwood Lake | 2366 | 2363 | 3 |
| UR30H3 | MR30R | 197 | Joe Rodgers Area - Leibenger Lane | 2275 | 2272 | 3 |
| UMR40E | MR40R | 178 | Upstream of Confluence with Antelope Creek | 7203 | 7288 | -85 |
| **Secret Ravine** | | | | | | |
| YE50F2 | SE50R | 235 | Brace Road | 4285 | 4287 | -2 |
| YSE51K | SE51R | 232 | Sierra College Blvd. | 4687 | 4689 | -2 |
| USE52D | SE52R | 231 | China Gardens Near Rustic Hills/Rocklin Road (Gage 1618) | 4641 | 4642 | -1 |
| YSE85Q | SE85R | 227 | Upstream of Confluence with Miners Ravine | 5431 | 5432 | -1 |
| **Clover Valley** | | | | | | |
| UCV10B | CV10R | 155 | Upstream of Confluence with Antelope Creek | 958 | 957 | 1 |
| **Antelope Creek** | | | | | | |
| YAC30B | AC30R | 140 | Sierra College Blvd. (Gage 1573) | 2834 | 2834 | 0 |
| UC35G3 | AC35R | 134 | Upstream of Confluence with Clover Valley - Midas Avenue | 2989 | 2989 | 0 |
| UC41E4 | AC41R | 126 | Antelope Creek Road - Downstream of SR-65 (Gage 1583) | 3616 | 3608 | 8 |
| UDC4D | AC45R | 122 | Upstream of Confluence with Miners Ravine | 3586 | 3577 | 9 |
| **Cirby Creek** | | | | | | |
| YCC40C | CC40R | 51 | Coloma Way (Gage 1635) | 932 | 931 | 1 |
| YCC45E | CCC5 | 49 | Upstream of Confluence with Linda Creek | 3258 | 3259 | -1 |
| **Strap Ravine** | | | | | | |
| UR20A4 | SR20R | 96 | Upstream of Confluence with Linda Creek @ McClaren (Gage 1611) | 1191 | 1191 | 0 |
| **Linda Creek** | | | | | | |
| ULC5B | LCC1 | 92 | Troy Purdee Lane | 559 | 559 | 0 |
| UC45J2 | LC45R | 82 | @ Sacramento County/Placer County Line | 2330 | 2330 | 0 |
| ULC80I | LC80R | 76 | Champion Oaks/Sanoma Way (Gage 1626/1628) | 2229 | 2229 | 0 |
| ULC95C | LC95R | 67 | Upstream of Confluence with Cirby Creek | 2728 | 2728 | 0 |
| YCC45G | CC45R | 45 | Upstream of Confluence with Dry Creek | 3225 | 3223 | 2 |
| **Dry Creek** | | | | | | |
| UDC5B | DC5R | 26 | Royer Park | 10362 | 10454 | -92 |
| YDCCC | RYCOMB | 23 | Confluence with Linda Creek/Cirby Creek | 8753 | 8755 | -2 |
| YDC10D | VERNON | 21 | Vernon Street Crossing | 12970 | 13066 | -96 |
| YDC71B | DCC11 | 9 | Sacramento County/Placer County Line | 12616 | 12679 | -63 |

Flow comparison impacted by bypass, in channel discharge listed.

## Table 15: Peak Flow (cfs) Impacts of Modification to Sierra College Boulevard at Secret Ravine

| 2007 NODE | 1992 HEC-1 NODE | 1992 Study Point # | Description | Recurrence Interval: / Model Hydrology: / Model Geometry: | 100-year 2007 Locally Detained Inflows 2010 Baseline (SCB@Secret) | 100-year 2007 Locally Detained Inflows 2007 System (w/ Miners) | Difference cfs |
|---|---|---|---|---|---|---|---|
| **Miners Ravine** | | | | Scenario: | 6 | 5 | |
| UR15K2 | MR15 | 207 | Dick Cook Road | | 1728 | 1727 | 1 |
| UR20P2 | MR20R | 205 | Moss Lane (Gages 1609/1610) | | 1913 | 1910 | 3 |
| YMR29I | MR29R | 202 | Cottonwood Lake | | 2366 | 2366 | 0 |
| UR30H3 | MR30R | 197 | Joe Rodgers Area - Leibenger Lane | | 2275 | 2275 | 0 |
| UMR40E | MR40R | 178 | Upstream of Confluence with Antelope Creek | | 7152 | 7203 | -51 |
| **Secret Ravine** | | | | | | | |
| YE50F2 | SE50R | 235 | Brace Road | | 4286 | 4285 | 1 |
| YSE51K | SE51R | 232 | Sierra College Blvd. | | 4617 | 4687 | -70 |
| USE52D | SE52R | 231 | China Gardens Near Rustic Hills/Rocklin Road (Gage 1618) | | 4598 | 4641 | -43 |
| YSE85Q | SE85R | 227 | Upstream of Confluence with Miners Ravine | | 5377 | 5431 | -54 |
| **Clover Valley** | | | | | | | |
| UCV10B | CV10R | 155 | Upstream of Confluence with Antelope Creek | | 958 | 958 | 0 |
| **Antelope Creek** | | | | | | | |
| YAC30B | AC30R | 140 | Sierra College Blvd. (Gage 1573) | | 2829 | 2834 | -5 |
| UC35G3 | AC35R | 134 | Upstream of Confluence with Clover Valley - Midas Avenue | | 2985 | 2989 | -4 |
| UC41E4 | AC41R | 126 | Antelope Creek Road - Downstream of SR-65 (Gage 1583) | | 3624 | 3616 | 8 |
| UDC4D | AC45R | 122 | Upstream of Confluence with Miners Ravine | | 3593 | 3586 | 7 |
| **Cirby Creek** | | | | | | | |
| YCC40C | CC40R | 51 | Coloma Way (Gage 1635) | | 932 | 932 | 0 |
| YCC45E | CCC5 | 49 | Upstream of Confluence with Linda Creek | | 3258 | 3258 | 0 |
| **Strap Ravine** | | | | | | | |
| UR20A4 | SR20R | 96 | Upstream of Confluence with Linda Creek @ McClaren (Gage 1611) | | 1191 | 1191 | 0 |
| **Linda Creek** | | | | | | | |
| ULC5B | LCC1 | 92 | Troy Purdee Lane | | 559 | 559 | 0 |
| UC45J2 | LC45R | 82 | @ Sacramento County/Placer County Line | | 2330 | 2330 | 0 |
| ULC80I | LC80R | 76 | Champion Oaks/Sanoma Way (Gage 1626/1628) | | 2229 | 2229 | 0 |
| ULC95C | LC95R | 67 | Upstream of Confluence with Cirby Creek | | 2728 | 2728 | 0 |
| YCC45G | CC45R | 45 | Upstream of Confluence with Dry Creek | | 3229 | 3225 | 4 |
| **Dry Creek** | | | | | | | |
| UDC5B | DC5R | 26 | Royer Park | | 10314 | 10362 | -48 |
| YDCCC | RYCOMB | 23 | Confluence with Linda Creek/Cirby Creek | | 8738 | 8753 | -15 |
| YDC10D | VERNON | 21 | Vernon Street Crossing | | 12908 | 12970 | -62 |
| YDC71B | DCC11 | 9 | Sacramento County/Placer County Line | | 12595 | 12616 | -21 |

Flow comparison impacted by bypass, in channel discharge listed.

## Table 16: Net Peak Flow (cfs) Impacts from 1992 through 2010

| 2007 NODE | 1992 HEC-1 NODE | 1992 Study Point # | Description | Recurrence Interval: / Model Hydrology: / Model Geometry: | 100-year, 2007 Locally Detained Inflows, 2010 Baseline (SCB@Secret) | 100-year, 1992 Baseline Inflows, 1992 Baseline System | Difference cfs |
|---|---|---|---|---|---|---|---|
| **Miners Ravine** | | | | Scenario: | 6 | 1 | |
| UR15K2 | MR15 | 207 | Dick Cook Road | | 1728 | 1714 | 14 |
| UR20P2 | MR20R | 205 | Moss Lane (Gages 1609/1610) | | 1913 | 1899 | 14 |
| YMR29I | MR29R | 202 | Cottonwood Lake | | 2366 | 2402 | -36 |
| UR30H3 | MR30R | 197 | Joe Rodgers Area - Leibenger Lane | | 2275 | 2268 | 7 |
| UMR40E | MR40R | 178 | Upstream of Confluence with Antelope Creek | | 7152 | 7427 | -275 |
| **Secret Ravine** | | | | | | | |
| YE50F2 | SE50R | 235 | Brace Road | | 4286 | 4219 | 67 |
| YSE51K | SE51R | 232 | Sierra College Blvd. | | 4617 | 4681 | -64 |
| USE52D | SE52R | 231 | China Gardens Near Rustic Hills/Rocklin Road (Gage 1618) | | 4598 | 4679 | -81 |
| YSE85Q | SE85R | 227 | Upstream of Confluence with Miners Ravine | | 5377 | 5447 | -70 |
| **Clover Valley** | | | | | | | |
| UCV10B | CV10R | 155 | Upstream of Confluence with Antelope Creek | | 958 | 987 | -29 |
| **Antelope Creek** | | | | | | | |
| YAC30B | AC30R | 140 | Sierra College Blvd. (Gage 1573) | | 2829 | 2819 | 10 |
| UC35G3 | AC35R | 134 | Upstream of Confluence with Clover Valley - Midas Avenue | | 2985 | 2982 | 3 |
| UC41E4 | AC41R | 126 | Antelope Creek Road - Downstream of SR-65 (Gage 1583) | | 3624 | 3630 | -6 |
| UDC4D | AC45R | 122 | Upstream of Confluence with Miners Ravine | | 3593 | 3605 | -12 |
| **Cirby Creek** | | | | | | | |
| YCC40C | CC40R | 51 | Coloma Way (Gage 1635) | | 932 | 758 | 174 |
| YCC45E | CCC5 | 49 | Upstream of Confluence with Linda Creek | | 3258 | 3096 | 162 |
| **Strap Ravine** | | | | | | | |
| UR20A4 | SR20R | 96 | Upstream of Confluence with Linda Creek @ McClaren (Gage 1611) | | 1191 | 919 | 272 |
| **Linda Creek** | | | | | | | |
| ULC5B | LCC1 | 92 | Troy Purdee Lane | | 559 | 545 | 14 |
| UC45J2 | LC45R | 82 | @ Sacramento County/Placer County Line | | 2330 | 2044 | 286 |
| ULC80I | LC80R | 76 | Champion Oaks/Sanoma Way (Gage 1626/1628) | | 2229 | 2158 | 71 |
| ULC95C | LC95R | 67 | Upstream of Confluence with Cirby Creek | | 2728 | 2682 | 46 |
| YCC45G | CC45R | 45 | Upstream of Confluence with Dry Creek | | 3229 | 3024 | 205 |
| **Dry Creek** | | | | | | | |
| UDC5B | DC5R | 26 | Royer Park | | 10314 | 10663 | -349 |
| YDCCC | RYCOMB | 23 | Confluence with Linda Creek/Cirby Creek | | 8738 | 8582 | 156 |
| YDC10D | VERNON | 21 | Vernon Street Crossing | | 12908 | 12635 | 273 |
| YDC71B | DCC11 | 9 | Sacramento County/Placer County Line | | 12595 | 12571 | 24 |

Flow comparison impacted by bypass, in channel discharge listed.

## Table 17: Unmitigated Peak Flow (cfs) Impacts of Future Development from 2010 to Build-out

| 2007 NODE | 1992 HEC-1 NODE | 1992 Study Point # | Description | Recurrence Interval: / Model Hydrology: / Model Geometry: | 100-year Unmitigated Build-out 2010 Baseline (SCB@Secret) | 100-year 2007 Locally Detained Inflows 2010 Baseline (SCB@Secret) | Difference cfs |
|---|---|---|---|---|---|---|---|
| **Miners Ravine** | | | | Scenario: | 7 | 6 | |
| UR15K2 | MR15 | 207 | Dick Cook Road | | 1791 | 1728 | 63 |
| UR20P2 | MR20R | 205 | Moss Lane (Gages 1609/1610) | | 1984 | 1913 | 71 |
| YMR29I | MR29R | 202 | Cottonwood Lake | | 2562 | 2366 | 196 |
| UR30H3 | MR30R | 197 | Joe Rodgers Area - Leibenger Lane | | 2456 | 2275 | 181 |
| UMR40E | MR40R | 178 | Upstream of Confluence with Antelope Creek | | 7322 | 7152 | 170 |
| **Secret Ravine** | | | | | | | |
| YE50F2 | SE50R | 235 | Brace Road | | 4856 | 4286 | 570 |
| YSE51K | SE51R | 232 | Sierra College Blvd. | | 5011 | 4617 | 394 |
| USE52D | SE52R | 231 | China Gardens Near Rustic Hills/Rocklin Road (Gage 1618) | | 4697 | 4598 | 99 |
| YSE85Q | SE85R | 227 | Upstream of Confluence with Miners Ravine | | 5497 | 5377 | 120 |
| **Clover Valley** | | | | | | | |
| UCV10B | CV10R | 155 | Upstream of Confluence with Antelope Creek | | 1135 | 958 | 177 |
| **Antelope Creek** | | | | | | | |
| YAC30B | AC30R | 140 | Sierra College Blvd. (Gage 1573) | | 2914 | 2829 | 85 |
| UC35G3 | AC35R | 134 | Upstream of Confluence with Clover Valley - Midas Avenue | | 3026 | 2985 | 41 |
| UC41E4 | AC41R | 126 | Antelope Creek Road - Downstream of SR-65 (Gage 1583) | | 4095 | 3624 | 471 |
| UDC4D | AC45R | 122 | Upstream of Confluence with Miners Ravine | | 3918 | 3593 | 325 |
| **Cirby Creek** | | | | | | | |
| YCC40C | CC40R | 51 | Coloma Way (Gage 1635) | | 943 | 932 | 11 |
| YCC45E | CCC5 | 49 | Upstream of Confluence with Linda Creek | | 3376 | 3258 | 118 |
| **Strap Ravine** | | | | | | | |
| UR20A4 | SR20R | 96 | Upstream of Confluence with Linda Creek @ McClaren (Gage 1611) | | 1250 | 1191 | 59 |
| **Linda Creek** | | | | | | | |
| ULC5B | LCC1 | 92 | Troy Purdee Lane | | 595 | 559 | 36 |
| UC45J2 | LC45R | 82 | @ Sacramento County/Placer County Line | | 2503 | 2330 | 173 |
| ULC80I | LC80R | 76 | Champion Oaks/Sanoma Way (Gage 1626/1628) | | 2245 | 2229 | 16 |
| ULC95C | LC95R | 67 | Upstream of Confluence with Cirby Creek | | 2755 | 2728 | 27 |
| YCC45G | CC45R | 45 | Upstream of Confluence with Dry Creek | | 3303 | 3229 | 74 |
| **Dry Creek** | | | | | | | |
| UDC5B | DC5R | 26 | Royer Park | | 10880 | 10314 | 566 |
| YDCCC | RYCOMB | 23 | Confluence with Linda Creek/Cirby Creek | | 8811 | 8738 | 73 |
| YDC10D | VERNON | 21 | Vernon Street Crossing | | 13535 | 12908 | 627 |
| YDC71B | DCC11 | 9 | Sacramento County/Placer County Line | | 13079 | 12595 | 484 |

Flow comparison impacted by bypass, in channel discharge listed.

## Table 18: Plan Update Unmitigated Build-out and Regulatory Peak Flows (cfs)

| 2007 NODE | 1992 HEC-1 NODE | 1992 Study Point # | Description / Recurrence Interval: / Model Hydrology: / Model Geometry: | 100-year Unmitigated Build-out 2010 Baseline (SCB@Secret) | 100-year 1992 Plan Future Not Applicable | 100-year FEMA FIS Not Applicable |
|---|---|---|---|---|---|---|
| **Miners Ravine** | | | Scenario: | 7 | 1992 Plan Future | FEMA FIS |
| UR15K2 | MR15 | 207 | Dick Cook Road | 1791 | 2277 | 3150 |
| UR20P2 | MR20R | 205 | Moss Lane (Gages 1609/1610) | 1984 | 2967 | None listed |
| YMR29I | MR29R | 202 | Cottonwood Lake | 2562 | 3202 | None listed |
| UR30H3 | MR30R | 197 | Joe Rodgers Area - Leibenger Lane | 2456 | 3421 | 4900 |
| UMR40E | MR40R | 178 | Upstream of Confluence with Antelope Creek | 7322 | 8428 | 7840 |
| **Secret Ravine** | | | | | | |
| YE50F2 | SE50R | 235 | Brace Road | 4856 | 3649 | 3080 |
| YSE51K | SE51R | 232 | Sierra College Blvd. | 5011 | 3814 | 3710 |
| USE52D | SE52R | 231 | China Gardens Near Rustic Hills/Rocklin Road (Gage 1618) | 4697 | 3820 | 4150 |
| YSE85Q | SE85R | 227 | Upstream of Confluence with Miners Ravine | 5497 | 4332 | 4200 |
| **Clover Valley** | | | | | | |
| UCV10B | CV10R | 155 | Upstream of Confluence with Antelope Creek | 1135 | 934 | 860 |
| **Antelope Creek** | | | | | | |
| YAC30B | AC30R | 140 | Sierra College Blvd. (Gage 1573) | 2914 | 2541 | 865 |
| UC35G3 | AC35R | 134 | Upstream of Confluence with Clover Valley - Midas Avenue | 3026 | 2703 | 2330 |
| UC41E4 | AC41R | 126 | Antelope Creek Road - Downstream of SR-65 (Gage 1583) | 4095 | 3500 | None listed |
| UDC4D | AC45R | 122 | Upstream of Confluence with Miners Ravine | 3918 | 3486 | 3080 |
| **Cirby Creek** | | | | | | |
| YCC40C | CC40R | 51 | Coloma Way (Gage 1635) | 943 | 1113 | 720 |
| YCC45E | CCC5 | 49 | Upstream of Confluence with Linda Creek | 3376 | 4614 | 4340 |
| **Strap Ravine** | | | | | | |
| UR20A4 | SR20R | 96 | Upstream of Confluence with Linda Creek @ McClaren (Gage 1611) | 1250 | 1054 | 920 |
| **Linda Creek** | | | | | | |
| ULC5B | LCC1 | 92 | Troy Purdee Lane | 595 | 640 | None listed |
| UC45J2 | LC45R | 82 | @ Sacramento County/Placer County Line | 2503 | 2774 | None listed |
| ULC80I | LC80R | 76 | Champion Oaks/Sanoma Way (Gage 1626/1628) | 2245 | 3612 | 3300 |
| ULC95C | LC95R | 67 | Upstream of Confluence with Cirby Creek | 2755 | 4464 | 4160 |
| YCC45G | CC45R | 45 | Upstream of Confluence with Dry Creek | 3303 | 4613 | 4130 |
| **Dry Creek** | | | | | | |
| UDC5B | DC5R | 26 | Royer Park | 10880 | 11358 | None listed |
| YDCCC | RYCOMB | 23 | Confluence with Linda Creek/Cirby Creek | 8811 | 15181 | 14000 |
| YDC10D | VERNON | 21 | Vernon Street Crossing | 13535 | 14830 | 14000 |
| YDC71B | DCC11 | 9 | Sacramento County/Placer County Line | 13079 | 15414 | 14000 |

Flow comparison impacted by bypass, in channel discharge listed.