InfoSWMM

RDII Analyst Overview

Welcome to the RDII Analyst!

Teach Me More About...	The RDII Analyst Interface	QA/QC of Data and Decomposing Flow Data
An Introduction to RDII Analyst	RDII Analyst Dialog Box	Data Correction
RDII Analyst Capabilities	Menus	Special Days Editor
Calibration Report	Contact Us	RDII Event Identification
RDI Event Analysis Results	Tool Buttons	DWF Extraction
Event Graph	GA Options	
RDII Time Series	Graphs and Reports	Calibrate RDII Parameters
Exporting Analysis Results	New Analysis Dialog Box	RDII Calibrate with Current Parameters

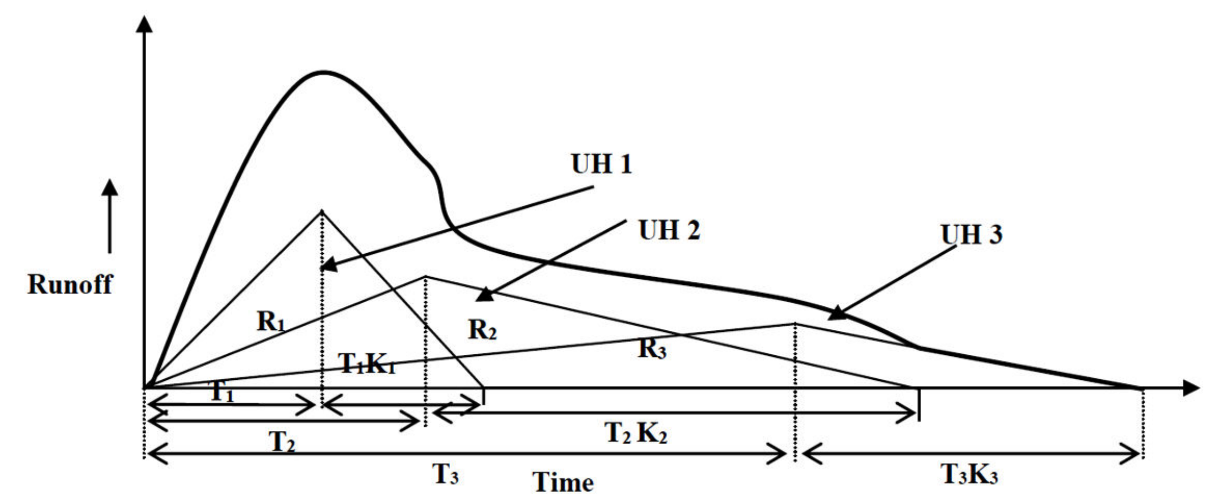
The processes for

converting rainfall to RDII flow in sanitary sewer systems are very complicated. In addition to rainfall and antecedent moisture conditions, factors controlling RDII responses include depth to groundwater, depth to bedrock, land slope, number and size of sewer system defects, type of storm drainage system, soil characteristics, and type of sewer backfill. Given this degree of complexity, flow-monitoring data must be combined with mathematical modeling and analytics to provide accurate results. The wastewater flow monitoring data obtained by sewer collection systems consists of dry-weather flow components, ground water flow and twelve (12) RDII flow components.

A crucial step in successfully modeling sewer collection systems is the ability to decompose flow-monitoring data into RDII flow, ground water flow and dry weather flow and its flow pattern. *RDII Analyst* helps you answer all of these questions with integrated DWF Patterns, GWI estimates and RTK parameters,

How the R (rainfall to flow fraction) and the T and K parameters (T*K

or the Base of the Unit Hydrograph) are related visually. There are three R, three T or time parameters and three K parameters.



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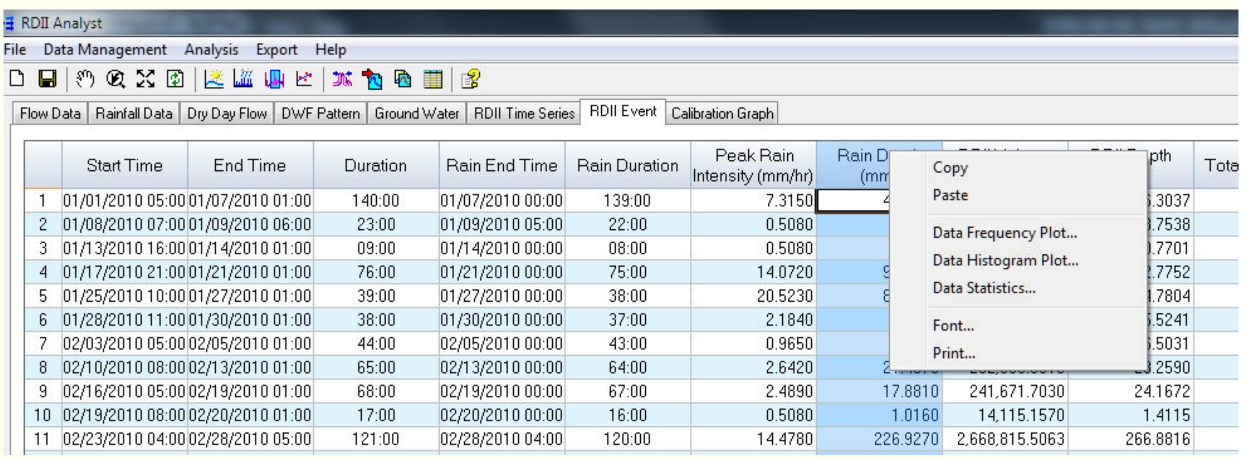
New Features in RDII Analyst

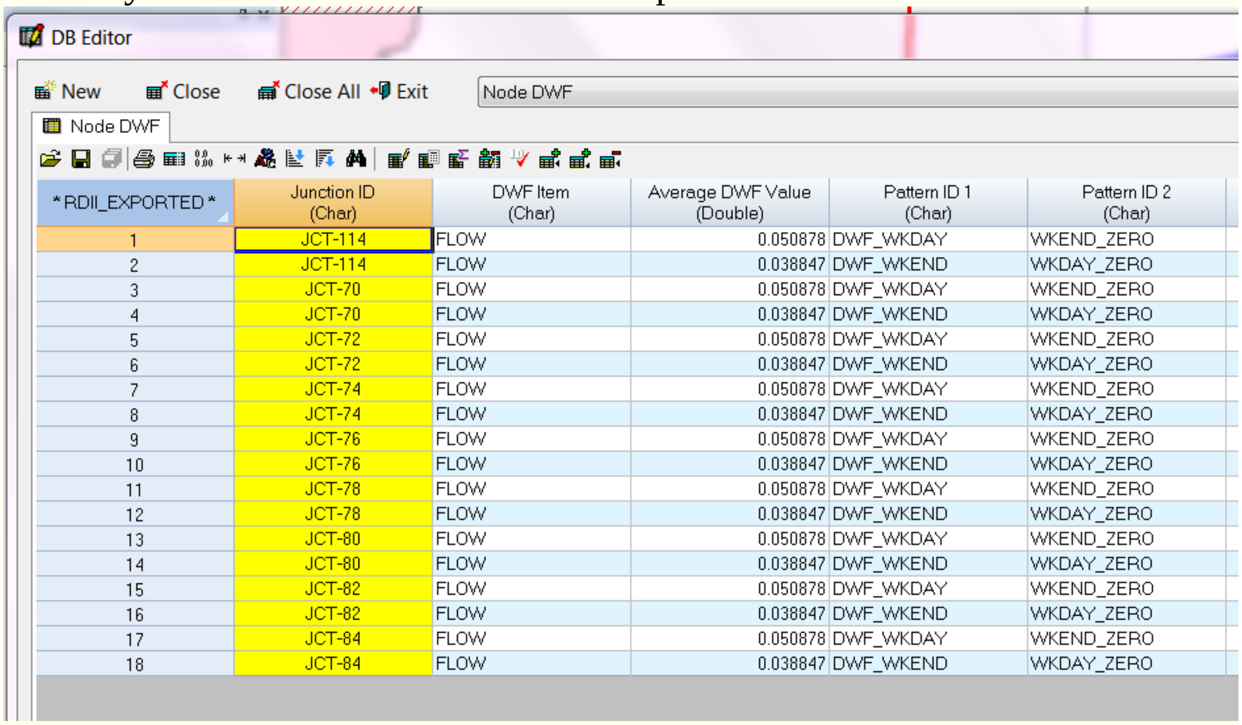
New to InfoSWMM 14.5

Update #1 is the ability to graph frequency and statistics for the event table. The new commands are:

- Copy
- Paste
- Data Frequency Plot
- Data Histogram Plot
- Data Statistics
- Font and
- Print



The DWF pattern is now exported in to rows for weekday and weekend with a zero pattern for weekend if the row is weekday and a zero pattern for weekday if the pattern is weekend



RDII_EXPORTED	Junction ID (Char)	DWF Item (Char)	Average DWF Value (Double)	Pattern ID 1 (Char)	Pattern ID 2 (Char)
1	JCT-114	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
2	JCT-114	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
3	JCT-70	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
4	JCT-70	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
5	JCT-72	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
6	JCT-72	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
7	JCT-74	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
8	JCT-74	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
9	JCT-76	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
10	JCT-76	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
11	JCT-78	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
12	JCT-78	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
13	JCT-80	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
14	JCT-80	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
15	JCT-82	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
16	JCT-82	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
17	JCT-84	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
18	JCT-84	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO

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RDII Analyst Introduction

Excessive wet weather flow resulting from rainfall-derived inflow and infiltration (RDII) is a major source of sanitary sewer overflows (SSOs). SSOs pose serious problems to the public and the environment by causing back up into basements and sewer overflows to streets and rivers. Control of sewer overflows is, therefore, vital to reducing risks to public health and protecting the environment from water pollution.

Computer modeling of sewer collection systems plays an important role in determining sound and economical remedial solutions that reduce RDII, improve system integrity, reliability and performance, and avoid overflows.

Although sanitary sewer systems are generally designed to accommodate RDII flows, these flows often exceed the design allowances. RDII represents total wet weather flow that enters the collection system in the form of inflow and infiltration. Inflow is water that enters the sewer system directly via depressed manhole lids and frames, downspouts, sump pumps, foundation drains, area way drains and cross-connections with storm sewers. Inflow typically occurs shortly after a rainfall starts and recedes quickly once it stops and typically accounts for the major component of the RDII peak flow. Infiltration refers to runoff that infiltrates into the soil before entering a sanitary sewer system through damaged pipe sections, leaky joints or poor manhole connections. Infiltration processes typically extend beyond the end of rainfall and takes some time to recede to zero after the storm event. Both infiltration and inflow increase with age of the sanitary sewer infrastructure.

Mathematical drainage modeling can be used to analyze existing sewer collection systems, to identify potential problems, and to design optimal remedial solutions. For sanitary sewer systems in particular, the ability to determine RDII flows reliably is critical for developing SSO control plans. The processes that convert rainfall to RDII flow in sanitary sewer systems are very complicated. Various factors control RDII responses in addition to the rainfall and antecedent moisture conditions, including depth to groundwater, depth to bedrock, land slope, number and size of sewer system defects, type of storm drainage system, soil characteristics, and type of sewer backfill. Furthermore, RDII responses can vary greatly due to spatial rainfall distributions over a sewershed. Given this degree of complexity, if not supplemented by flow monitoring data, mathematical modeling of RDII inflows may not yield the degree of reliability desired to identify existing problems and to make sound and economical decisions to correct the identified problems.

The wastewater flow monitoring data collected at sewer collection systems consists of dry-weather flow components and RDII flow components. A crucial step towards successful modeling of sewer collection systems is the ability to decompose the flow monitoring data into the RDII flow and the dry-weather flow. The dry-weather flow component can be further classified into ground water flow and base flow. Groundwater flow represents the groundwater infiltration that enters the collection system through defective pipes, pipe joints, and leaking manhole walls irrespective of rainfall availability. Base wastewater flow represents sewage from residential, commercial, and industrial areas released to the sanitary sewer system. RDII is the rainfall-driven flow that makes its way to the collection system. The decomposition process can then be used to understand the sources of flow and the relative quantities of each flow components for the sewer system. Additionally, it determines if RDII and groundwater flow components are excessive to cause SSOs and other operational problems.

RDII Analyst performs comprehensive QA/QC of rainfall and flow data and decomposes the flow data into distinct dry-weather flow (DWF) and wet-weather flow (RDII) components using criteria such as rainfall threshold. The DWF component is further analyzed to construct a DWF pattern that can be used to simulate the system using InfoSWMM .

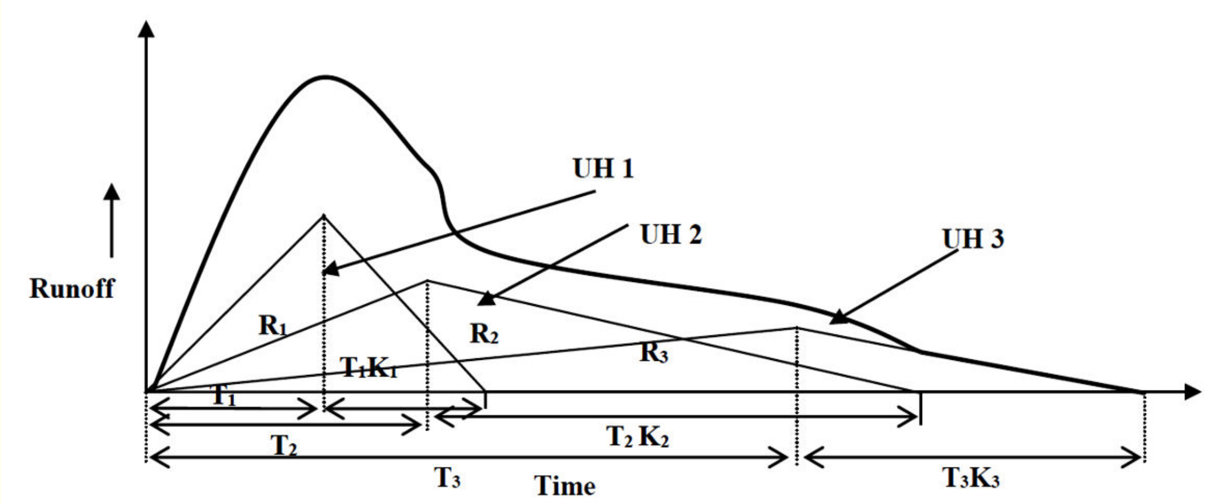
The DWF pattern is then assigned to the source nodes that contribute DWF

to the meter location in proportion to sewershed areas or based on other user-defined criteria. The RDII component is then analyzed to determine RDII events and to calibrate parameters of the RTK synthetic unit hydrograph so that the RDII flow simulated by the RTK method closely matches the RDII flow obtained by the decomposition process. The RTK unit hydrograph parameters are calibrated with genetic algorithm optimization. The calibrated RTK parameters and the DWF patterns are then passed to InfoSWMM

to carry out detailed dynamic flow routing through the sewer system and evaluate system response to support development of an optimal capital improvement program.

Powerful, comprehensive and user-friendly, *RDII Analyst* reflects Innovyze® Inc's time-honored practice of continually adding value to its world-class software and bringing critical new design capabilities to the industry. We are happy to bring you the state-of-the-art in RDII flow analysis and management technology to help you accurately analyze and manage your infrastructures. Our high-level, state-of-the-art research and development effort is continuing at a rapid pace and we intend to update and refine *RDII Analyst* to reflect this progress.

We are pleased to be at the forefront of this computer technology and to continue to advance it to an unprecedented level of reliability and performance. In months to come, *RDII Analyst* will grow to include even more features that are powerful and make your work more efficient and effective.



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President, COO and Chief Technical Officer

Innovyze Inc.

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RDII Analyst Capabilities

The wastewater flow monitoring data at sewer collection systems consists of dry-weather flow components and Rainfall Derived Infiltration/Inflow (RDII) flow components. The dry-weather flow component can be further classified into ground water flow and base flow. Groundwater flow represents the groundwater infiltration that enters the collection system through defective pipes, pipe joints, and leaking manhole walls irrespective of rainfall availability. Base wastewater flow represents sewage from residential, commercial, and industrial areas released to the sanitary sewer system.

RDII is the rainfall-driven flow that makes its way to the collection system. One of the crucial steps towards successful modeling of sewer collection systems is the ability to decompose the flow monitoring data into base wastewater flow, ground water flow and the RDII flow. The decomposition process can then be used to understand the sources of flow and the relative quantities of each flow components for the sewer system. Additionally, it determines if RDII and groundwater flow components are excessive to cause Sanitary Sewer Overflow (SSOs) and other operational problems.

Before decomposition is carried out, it is imperative to carefully analyze both rainfall data and flow data and to perform rigorous QA/QC. RDII Analyst allows you to review and edit data and to correct suspicious records.

Days with non-representative flow records (e.g., holidays) can be discarded from the analysis. Data affected by meter failure, system disruptions or other factors that could cause abnormal wastewater flows can also be removed. Once the flow data and the rainfall data are reviewed and corrected, RDII Analyst begins the decomposition process by identifying dry days and wet days to determine the dry-weather flow components and the RDII components. A day is defined as dry day if rainfall depth is less than a pre-specified threshold within a given duration. In addition, statistical analysis is employed to further test if a day qualifies as a dry day.

Groundwater flow is determined based on the dry days. Next, groundwater flow is subtracted from flow data for the identified dry days to determine base wastewater flow (BWF). The BWF component is grouped into weekdays and weekend days and average hourly base wastewater flow values are determined for each group. The BWF pattern and the GWF pattern are allocated to the tributary nodes in proportion to the sewershed area and other user-defined criteria. RDII flow is then determined by subtracting the BWF pattern and the groundwater flow pattern from the total measured flow data. The RDII flow is further analyzed to determine RDII events, and to formulate a regression equation that relates RDII flow volume with rainfall volume across the RDII events.

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uses the RTK unit hydrograph (UH) method to estimate RDII flow into a sewer system. An RTK UH set contains up to three such hydrographs, one for a short-term response, one for an intermediate-term response, and one for a long-term response. Each of these three unit hydrographs is defined by three parameters. The R parameter represents the fraction of rainfall volume that enters the sewer system, T represents the time from the onset of rainfall to the peak of the UH in hours, and K represents the ratio of time to recession of the UH to the time to peak. A UH group can also have a set of Initial Abstraction (IA) parameters associated with it. These parameters determine how much rainfall is lost to interception and depression storage before any excess rainfall is generated and transformed into RDII flow by a unit hydrograph. The IA parameters consist of a maximum possible depth of IA (inches or mm), a recovery rate (inches/day or mm/day) at which stored IA is depleted during dry periods, and an initial depth of stored IA (inches or mm). Accurate determination (calibration) of the UH parameters is crucial to simulate RDII flow using v

with the degree of certainty required to design sound mitigation plans to control SSOs and other operational problems.

Traditionally, calibration of RDII UH parameters is performed through a tedious and inexact trial-and-error process in which the parameters are manually adjusted in an iterative fashion to closely match wet-weather flow data. Since there are a vast number of possible combinations of RTK values, evaluating all options this way may not be manageable, and even knowledgeable modelers often fail to obtain good results. RDII Analyst uses Genetic Algorithms (GA) optimization to automatically determine the UH parameters that best match the RDII time series generated by decomposing the measured flow data with the RDII flow estimated using InfoSWMM

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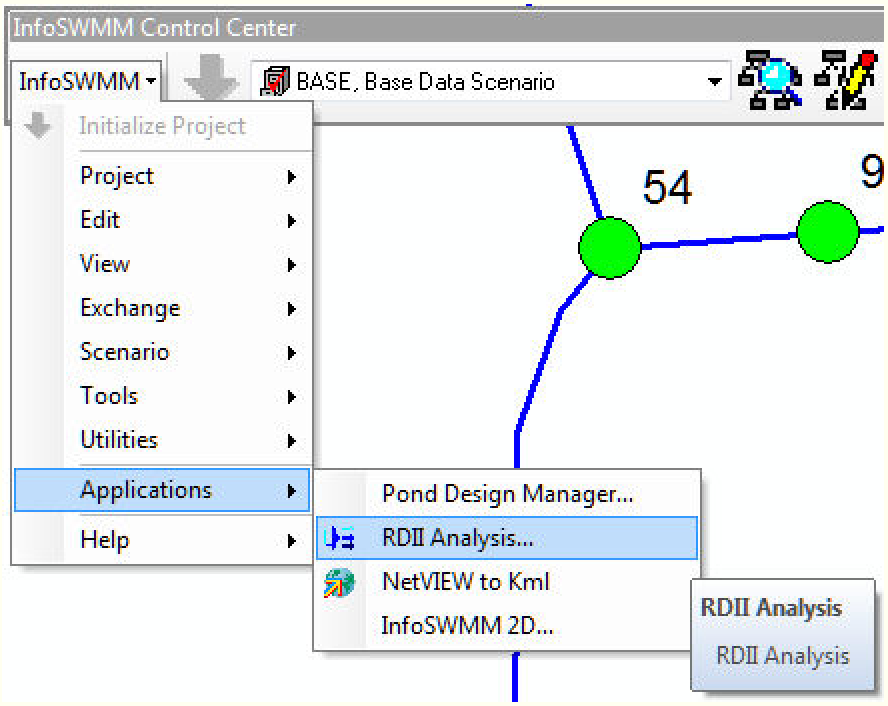

See Also

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Chapter 7 – Rainfall Dependent Inflow and Infiltration from the EPA SWMM 5 Hydrology Manual

7.1 Introduction

Rainfall dependent (or rainfall-derived) inflow and infiltration (RDII) are stormwater flows that enter sanitary or combined sewers due to "inflow" from direct connections of downspouts, sump pumps, foundation drains, etc. as well as "infiltration" of subsurface water through cracked pipes, leaky joints, poor manhole connections, etc. RDII can be a significant cause of sanitary sewer overflows (SSOs) of untreated wastewater into basements, streets and other properties, as well as receiving streams. It can also cause significant flow increases to wastewater treatment plants resulting in hydraulic overloading and disruption of plant processes.

SWMM treats RDII as a separate category of external inflows that enters the conveyance system at specific user-designated nodes. It is computed independently of the surface runoff, infiltration, snowmelt and groundwater processes described in previous chapters of this manual. RDII flow is added onto the other inflow categories (such as dry weather sanitary flow, overland runoff, and groundwater interflow) during each time step of a simulation. RDII calculations were added to version 4 of SWMM by C. Moore of CDM in 1993. This chapter describes how these RDII flows are computed from the precipitation records supplied to a SWMM data set.

Note: This section is an adaptation from the Storm Water Management Model Reference Manual Volume I – Hydrology By: Lewis Rossman U.S. Environmental Protection Agency Office of Research and Development National Risk Management Laboratory Cincinnati, OH 45268 National Risk Management Laboratory Office of Research and Development U.S. Environmental Protection Agency 26 Martin Luther King Drive Cincinnati, OH 45268 July 2015

7.2 Governing Equations

Figure 7-1 depicts the three major components of wet-weather wastewater flow within a sanitary sewer system (Vallabhaneni et al., 2007). These are base sanitary flow (BSF), groundwater infiltration(GWI), and RDII. BSF is the flow discharged to sanitary sewersby homes, businesses, institutions, and industrial water users throughout the normal course of a day. It exhibits a typical diurnal pattern, with higher flows during the morning and early evening hours and lower flows overnight. The average daily BSF remains more or less constant during the week, but can vary by both month and season.

GWI consists of groundwater that enters the collection system through cracked pipes, pipe joints and manhole walls during extended periods of time when water table levels are high, even in the absence of any rainfall. It is different from RDII because it does not occur as a direct response to a rainfallevent. GWI variesthroughout the year,with the highestrates in late winter and spring as groundwater levels rise, and the lowest rates (or no GWI at all) during late summer or after an extended dry period.

RDII is the flow that can be directlyattributed to a rainfall event.This flow is zero beforethe start of the event, increases during the event,and declines back to zero sometime after the event is over. The start of the RDII response may be delayed during the time it takes for surfaces to capture a portion of the initial rainfall and for soils to become saturated. If the event is small enough, then no RDII at all may be generated. The maximum volume of rainfallthat does not produce any RDII response is referred to as "initial abstraction" (Vallabhaneni et al., 2007).

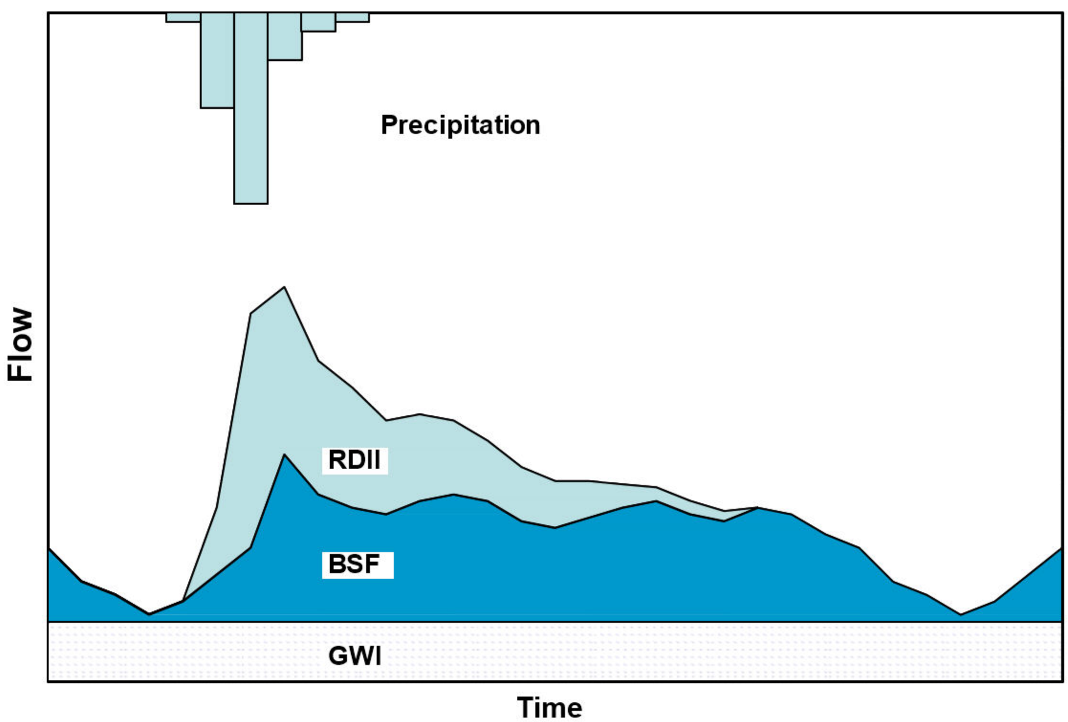

Figure 7-1 Components of wet-weather wastewater flow.

Quantitative estimates of RDII are almost always derived from actual wastewater flow records as opposed to attempting to model the distributed set of small scale physical processes directly responsible for RDII. Methods for modeling RDII are reviewed by Bennet et al. (1999) and Lai (2008). SWMM uses the RTK unit hydrograph approach, which is among the most flexible and widely used RDII methods (Vallabhaneni et al., 2007). (The initials RTK stand for the three parameters that characterize the unit hydrographs used by the method.)

The RTK unit hydrograph method was first developed by CDM-Smith consultants in an RDII study for the East Bay Municipal Utility District in Oakland, CA (Giguere and Riek, 1983). It represents the response of a sewershed to a rainfall event through a series of up to three triangular unit hydrographs. These unit hydrographs can be applied to any particular storm event to produce a resulting time history of RDII flow rates.

Figure 7-2 shows a single triangular unit hydrograph assumed to represent the RDII flow induced by one unit of rainfall over a unit of time. This unit hydrograph is characterized by the following parameters:

R: the fraction of rainfall volume that enters the sewer system and equals the volume under the hydrograph

T: the time from the onset of rainfall to the peak of the unit hydrograph *K*: the ratio of time to recession of the unit hydrograph to the time to peak Q_{peak}: peak flow (per unit area) on the unit hydrograph.

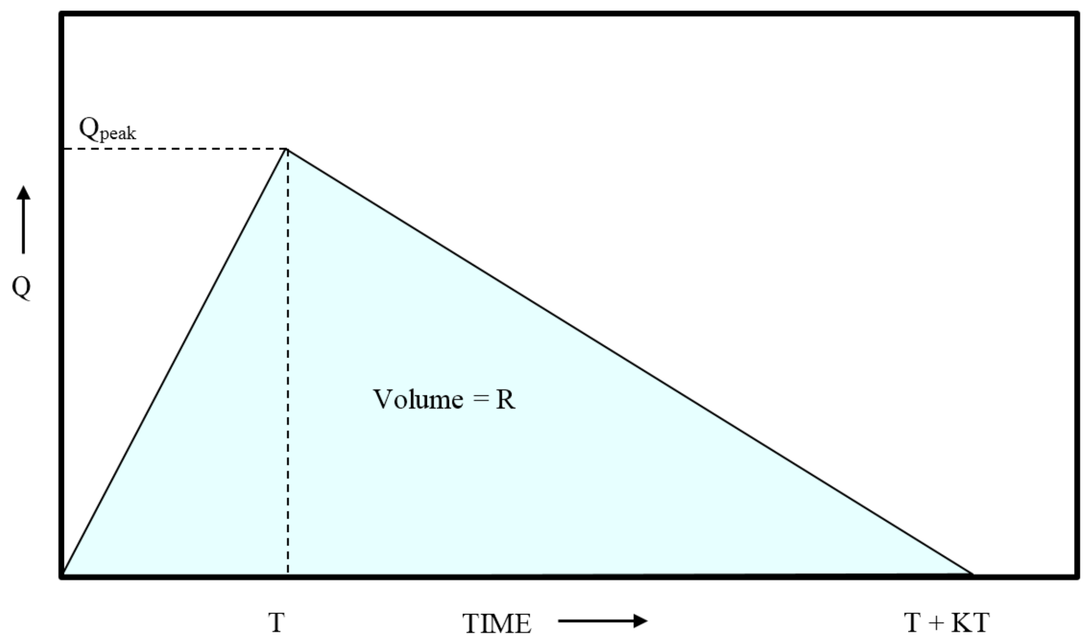

Figure 7-2 Example of an RDII triangular unit hydrograph.

Figure 7-3 shows how this single unit hydrograph would be applied to a storm that consists of three time periods of varying rainfall volume. The original unit hydrograph is replicated for each rainfall time period, with its origin offset by the time period and its ordinates multiplied by the rainfall volume for that period. The overall response to the storm is the hydrograph obtained by summing the ordinates of the volume-adjusted hydrographs at each time point. The volumetric RDII inflow into the conveyance system is the ordinate of the composite hydrograph multiplied by the contributing area of the affected sewershed. This process of adding together the rainfall- adjusted, time-shifted hydrographs is known as convolution (Chow et al, 1988) and is expressed mathematically as:

$$Q_t = \sum_{j=1}^{t} U_{t-j+1} P_j \tag{7-1}$$

where:

Q_t	=	RDII flow per unit area during time period t,
U_t	=	ordinate of the unit hydrograph for time period t,
P_j	=	depth of rainfall for time period j.

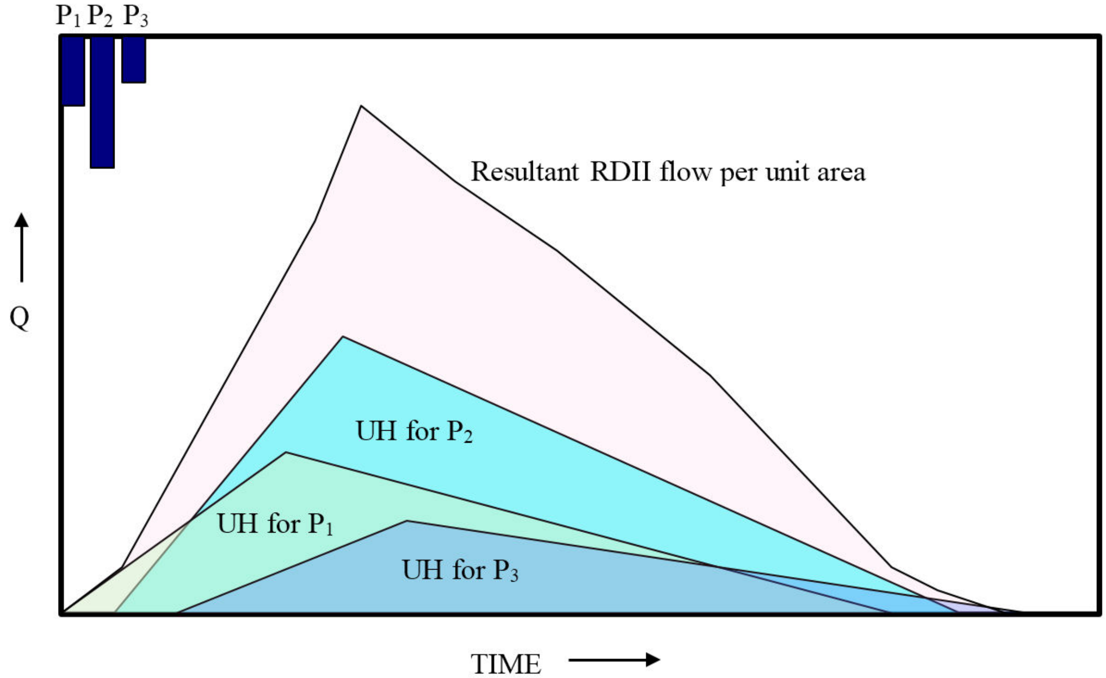

Figure 7-3 Application of a unit hydrograph to a storm event.

The ordinate value U_j for time period is determined from the shape parameters *R*, *T*,and *K* of the unit hydrograph as follows. One can write:

The ordinate value U_j for time period *j* is determined from the shape parameters *R*, *T*, and *K* of the unit hydrograph as follows. One can write:

$$U_j = f_j Q_{peak} \tag{7-2}$$

where f_j is the fraction of the rising limb (or falling limb) that corresponds to time period *j*. Because the area under the unit hydrograph is *R*, the value of Q_{peak} is:

$$Q_{peak} = \frac{2R}{T + KT} \tag{7-3}$$

Thus U_j can be expressed as:

$$U_j = \frac{2Rf_j}{T + KT} \tag{7-4}$$

By convention, the time τ_j on the unit hydrograph base corresponding to time period *j* is taken as the midpoint between either ends of the time interval:

$$\tau_j = (j - 0.5)\Delta\tau \tag{7-5}$$

where $\Delta\tau$ is the time interval over which precipitation is recorded. The fraction f_j is then determined as:

$$f_j = \frac{\tau_j}{T} \qquad \text{for } \tau_j <= T \tag{7-6}$$

$$f_j = 1 - \frac{\tau_{j-T}}{KT} \qquad \text{for } T < \tau_j <= T + KT \tag{7-7}$$

$$f_j = 0 \qquad \text{for } \tau_j > T + KT \tag{7-8}$$

Because actual RDII hydrographs have complex shapes,three different hydrographs of increasing durations are typically used to represent the overall RDII unit response (Vallabhaneni et al., 2007). The first hydrograph modelsthe most rapidlyresponding inflow component usually caused by direct sources of inflow, and has a time to peak *T* of one to three hours. The second includes both rainfall-derived inflow and infiltration, and has a longer *T* value. The third represents infiltration that may continue long after the storm event has ended and has the longest *T* value. Figure 7-4 depicts how the three unit hydrographs are summed together to produce a total RDII hydrograph in response to a unit of rainfall over one unit of time. Equation 7-1 is still used to compute the overall RDII hydrograph to any given storm event, with a separate Q_t computed for each of the three unit hydrographs. These are then added togetherto produce the total flow per unit area for time period *t*.

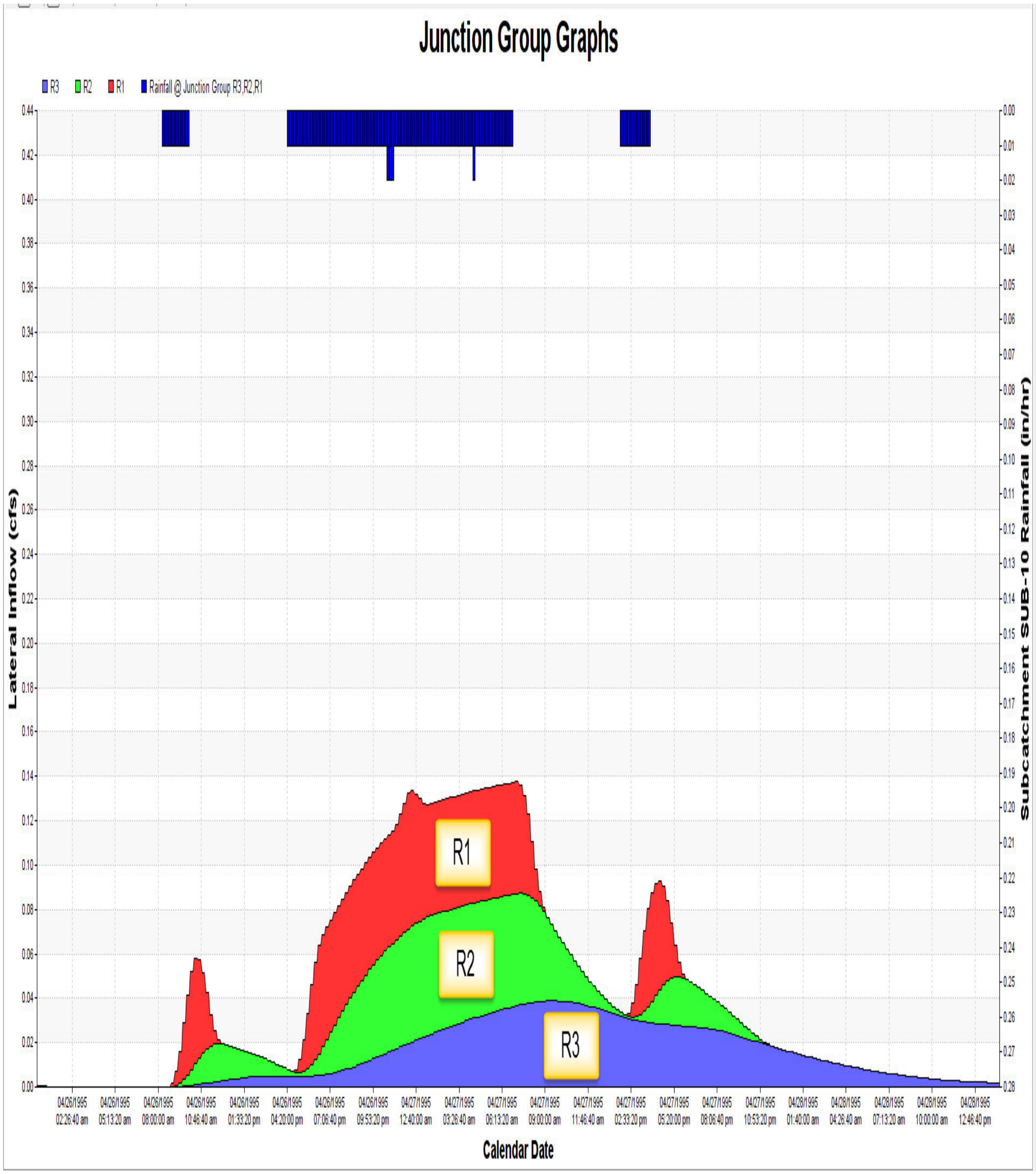

Figure 7-4 Use of three unit hydrographs to represent RDII (Vallabhaneni et al., 2007).

Not all storms will result in measurable inflow/infiltration. Just as with ordinary runoff, a certain initial volume of rainfall will be captured by surface ponding, interception by flat roofs and vegetation, and surface wetting and will not contribute to RDII. This phenomenon is represented in SWMM by three user-supplied "initial abstraction" (*IA*) parameters that accompany each RDII unit hydrograph. IA_{max} (in or mm) is the maximum depth of initial abstraction capacity available for the sewershed. IA_0 (in or mm) is the amount of that capacity already used up at the start of the simulation. IA_r (in/day or mm/day) is the rate at which capacity becomes available again during periods of no rainfall. During storm events, the volume of rainfall applied to the unit hydrograph convolution formula, Equation 7-1, is reduced by the amount of initial abstraction capacity remaining. During dry periods, this capacity is regenerated based on the user-supplied recovery rate.

7.3 Computational Scheme

SWMM generates RDII inflows for specific nodes of a sewer system.Recall from Section1.2 that SWMM uses a networkof links and nodes to represent the conveyance portionof a drainage area. For RDII applications this network would be the sewer system (either sanitary or combined), the links are the sewer pipes and the nodes are points where pipes connect to one another (e.g., manholes or pipefittings).

It should be noted once again that RDII is computed independently from any surface runoff or groundwater flow generated from the subcatchments contained in a SWMM model.The sewershed that produces RDII flow for a specific sewer system node is not represented explicitly in SWMM and need not correspond to any of the runoffsubcatchments defined for the studyarea. In fact it is perfectly acceptable (and quite common for sanitary sewer systems) to conduct an RDII analysis without including any subcatchments in the model. In this case the model would consist of a set of Rain Gage objects (and their data sources), the node and link objects that make up the sewer network and sets of user-supplied time series that describe groundwater (GWI) and sanitary(BSF) flows.

SWMM computes all RDII inflow time series prior to the start of a simulation and saves these inflow values to an interface file. Each line of the file contains, in chronological order, a node ID name, a date, a time of day, and the RDII inflow value for that node. Dates with no RDII inflows are not recorded. To compute the entries of this file the following quantities are assumed known for each node of the conveyance system node that receives RDII inflows:

- the area (A) of the sewershed that contributes RDII to the node,
- the *R-T-K* parameters for each of three RDII unit hydrographs,
- the initial abstraction parameters (IA_{max}, IA_0, and IA_r) associated with each RDII unit hydrograph,
- the time series of rain volumes that fall on the sewershed and their recording interval $\Delta\tau$ (sec) as provided by a SWMM Rain Gage object.

The steps used to process a precipitation record against a set of unit hydrographs to produce a record of RDII inflows for a specific conveyance node are described in the sidebar shown below.

Computational Scheme for RDII

First define the following variables:

T_{tot} = total elapsed time (sec)

T_{gage} = total time elapsed time for the rainfall record (sec)

T_{base} = time base of a unit hydrograph, $= T + KT$ (sec)

T_{dry} = time since the last rainfall (sec)

Δt_{WET} = wet time step used for runoff computations (sec) (see Section 3.6)

P = vector of past rainfall volumes (ft)

Then do the following for each conveyance system node designated to receive RDII flow:

1. Initialize the following quantities:

   $T_{tot} = 0$

   $T_{gage} = 0$

   $T_{dry} = T_{base} + 1$

   $IA = IA_{max} - IA_0$

   $P = 0$

2. Repeat the following sub-steps until $T_{gage} > T_{tot}$:

   a. retrieve the rain volume v over the rain gage recording interval at time T_{gage}

   b. if there is any rainfall, reduce it by any available initial abstraction; otherwise recover initial abstraction over the time step $\Delta\tau$

   c. if there is still rainfall excess and $T_{dry} > T_{base}$ then begin a new RDII event by setting all entries in P to 0 and set $T_{dry} = 0$; otherwise add $\Delta\tau$ to T_{dry}

   d. save the rain volume in the next available entry in P

   e. add $\Delta\tau$ to T_{gage}.

3. If $T_{dry} < T_{base}$ then apply convolution to the vector of past rainfall volumes and the unit hydrograph ordinates to compute an RDII flow per unit of sewershed area.

4. If the RDII flow is non-zero, multiply it by the node's sewershed area and save the current date at T_{tot} and the RDII flow value to the interface file.

5. Add Δt_{WET} to T_{tot} and return to Step 2 if T_{tot} is less than the total duration.

(Continued on next page)

Note that RDII flows are computed for each runoff wet time step but that precipitation records and the RDII convolution are processed at the rain gage recording interval time step.

The application of the initial abstraction at Step 2b of this process proceeds as follows:

1. If $v > 0$ then:

   a. if IA > v then IA = IA – v and v = 0;

   b. else if $IA > 0$ then $v = v - IA$ and $IA = 0$.

2. If v = 0 then IA = min(IA_{max}, IA + $IA_r \Delta\tau$)

Calculation of the RDII flow at Step 3 is carried out by adding together the products $U_j P_i$ for each of the unit hydrographs as the hydrograph index j is incremented from 1 to the number of hydrograph intervals (equal to $T_{base} / \Delta\tau$) while the rainfall index i is decreased from the current period back an equal number of time intervals. Equations 7-2 through 7-7 are used to compute U_j for each of the three unit hydrographs.

7.4 Parameter Estimates

To use SWMM's RDII option a user must supply estimates of the three parameters (R, T, and K) that define each of three unit hydrographs for each node where RDII enters the sewer system.Each unit hydrograph can also have a set of initial abstraction parameters (Ia_0, Ia_{max}, and Ia_r). SWMM also allows one to specify different sets of unit hydrographs and initial abstraction parameters for differentmonths of the year. In addition, the area of the RDII contributing sewershed must also be specified.

R-T-K parameters are derived from site-specific flow monitoring data. There are no generalvalues that can be applied in the absence of actual field data. All of these parameters require that a continuous flow monitoring program be implemented at strategic points in the sewer system. As described in Vallabhaneni et al., 2007, estimating the RDII unit hydrograph parameters for a sewershed involves the following activities:

1. Identify the sewershed areas that are tributary to the flow monitor (see Figure 7-5).

2. Extract the RDII portion of the recorded flow at the monitoring station during a wet weather event (see Figure 7-6).

3. Estimate the R-T-K values for each of three unit hydrographs whose resultant hydrograph best matches the RDII flow extracted from the flow record (see Figure

7-7).

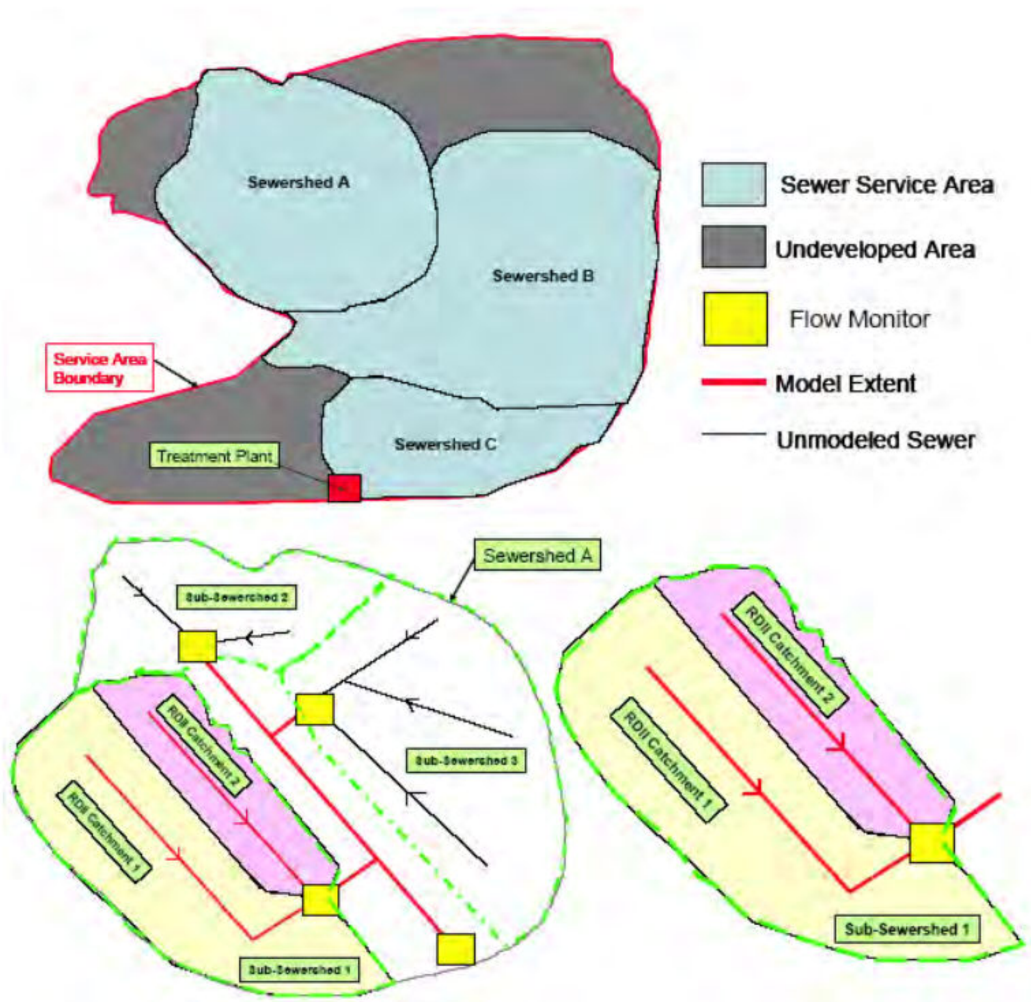

Figure 7-5 Sewershed delineation (Vallabhaneni et al., 2007).

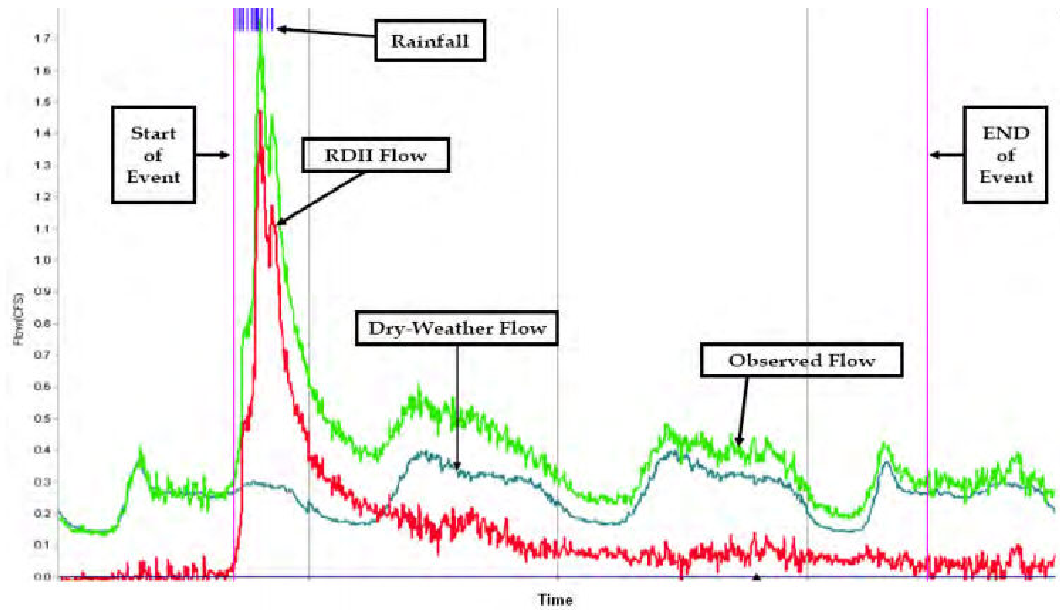

Figure 7-6 Extracting RDII flow from a continuous flow monitor (Vallabhaneni et al., 2007).

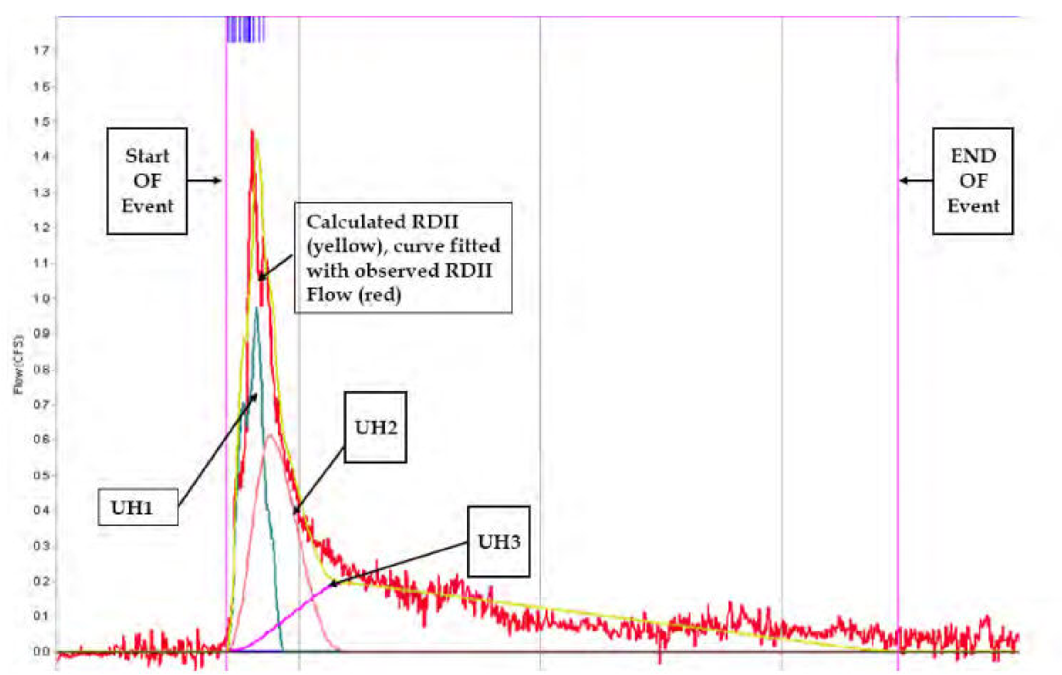

Figure 7-7 Fitting unit hydrographs to an RDII flow record (Vallabhaneni et al., 2007).

7.5 Numerical Example

A simple example illustrates how SWMM constructs an RDII interface file for use within a hydraulic simulation. Assume there is a single rain gage whose rainfall time series is shown in Table 7-1. Note that the recording intervalis 1 hour, and that there are two eventsseparated by 22 hours. SWMM will use data from this gage to construct a time series of RDII flows for a node named N1 in the conveyance systemthat services an area of 10 acres.There is a single group of 3 unit hydrographs used to derive RDII from the rain gage data. The shapes and parameters of the unit hydrographs (UH1, UH2, and UH3) are shown in Figure 7-8. Note that the R-values of this set of unit hydrographs sum to 0.36, implying that 36 percent of total rainfall volume winds up as RDII. To keep things simple, initial abstraction is not considered in this example.

Table 7-1 Rainfall time series for the illustrative RDII example

Hour	Rainfall (inches)
0:00	0.0
1:00	0.25
2:00	0.5
3:00	0.8
4:00	0.4
5:00	0.1
6:00	0.0
27:00	0.0
28:00	0.4
29:00	0.2
30:00	0.0

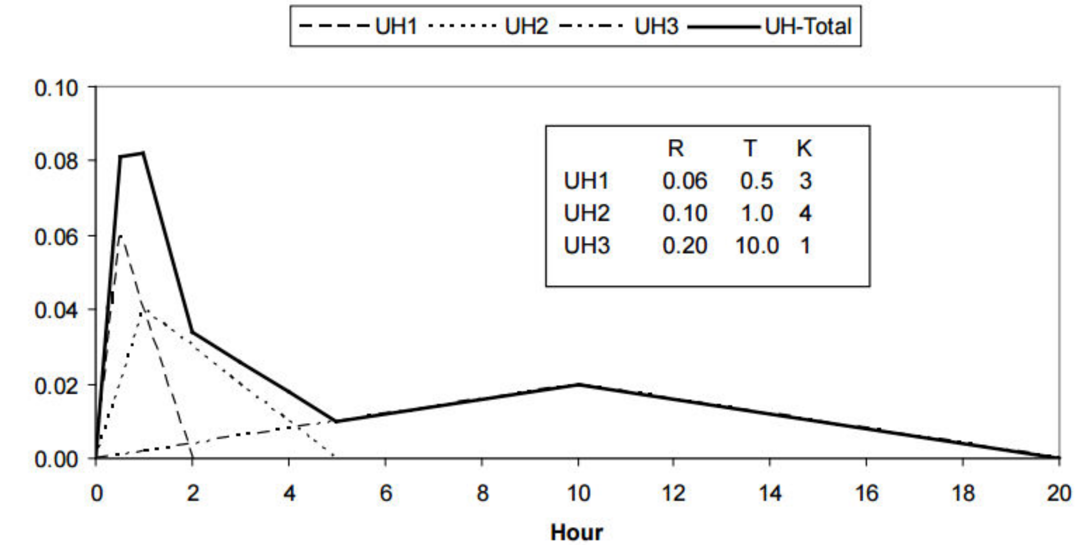

Figure 7-8 Unit hydrographs used for the illustrative RDII example.

The resulting RDII flows are depicted in Figure 7-9. SWMM places these flows into an RDII interface file, a portion of which is displayed in Figure 7-10. This file is accessed during the flow routing portion of a SWMM run to add RDII inflow into node N1 at each time step of the routing process.

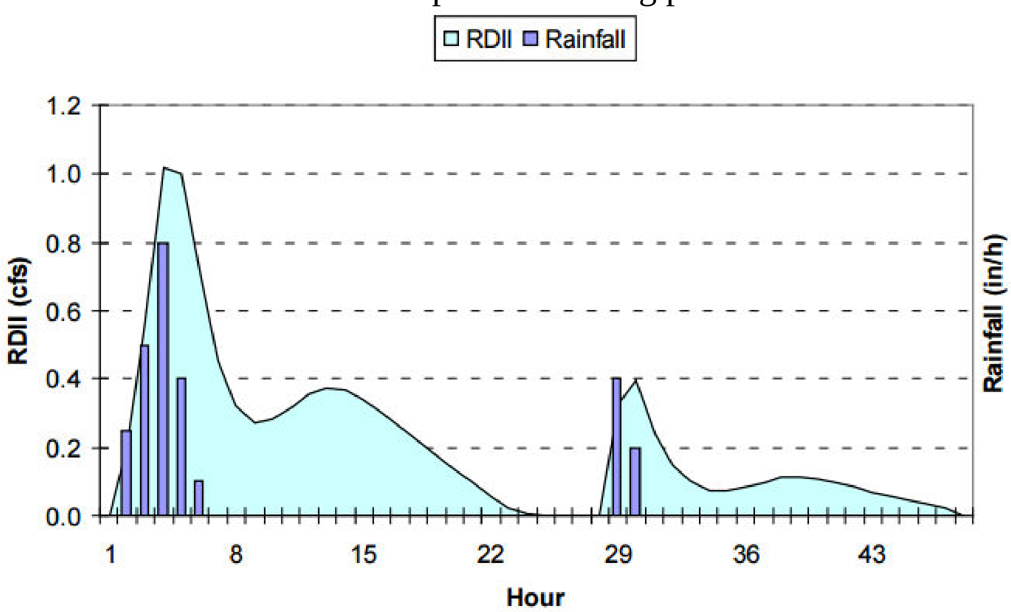

Figure 7-9 Time series of RDII flows for the illustrative RDII example.

N1

Node N1	Year Mon Day Hr 2002 02 02 01			Min Sec FLOW 15 00 0.204195		
N1	2002 02	02	01	30	00	0.204195
N1	2002 02	02	01	45	00	0.204195
N1	2002 02	02	02	00	00	0.204195
N1	2002 02	02	02	15	00	0.554604
N1	2002 02	02	02	30	00	0.554604
N1	2002 02	02	02	45	00	0.554604
N1	2002 02	02	03	00	00	0.554604
N1	2002 02	02 03		15	00	1.021479
N1	2002 02	02	03	30	00	1.021479
N1	2002 02	02	03	45	00	1.021479
N1	2002 02	02	04	00	00	1.021479
N1	2002 02	02	04	15	00	1.001312
N1	2002 02	02	04	30	00	1.001312
N1	2002 02	02	04	45	00	1.001312
N1	2002 02	02	05	00	00	1.001312
N1	2002 02	02	05	15	00	0.703842
N1	2002 02	02	05	30	00	0.703842
N1	2002 02	02	05	45	00	0.703842
N1	2002 02	02	06	00 00		0.703842

```
SWMM5 Interface File

900 - reporting time step in sec
1 - number of constituents as listed below:
FLOW CFS
1 - number of nodes as listed below:
N1
Node       Year Mon Day Hr  Min Sec FLOW
N1         2002 02  02  01  15  00  0.204195
N1         2002 02  02  01  30  00  0.204195
N1         2002 02  02  01  45  00  0.204195
N1         2002 02  02  02  00  00  0.204195
N1         2002 02  02  02  15  00  0.554604
N1         2002 02  02  02  30  00  0.554604
N1         2002 02  02  02  45  00  0.554604
N1         2002 02  02  03  00  00  0.554604
N1         2002 02  02 03  15  00  1.021479
N1         2002 02  02  03  30  00  1.021479
N1         2002 02  02  03  45  00  1.021479
N1         2002 02  02  04  00  00  1.021479
N1         2002 02  02  04  15  00  1.001312
N1         2002 02  02  04  30  00  1.001312
N1         2002 02  02  04  45  00  1.001312
N1         2002 02  02  05  00  00  1.001312
N1         2002 02  02  05  15  00  0.703842
N1         2002 02  02  05  30  00  0.703842
N1         2002 02  02  05  45  00  0.703842
N1         2002 02  02  06  00 00  0.703842
```

Figure 7-10 Excerpt from the RDII interface file for the illustrative RDII example.

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About RDII Analyst

On-Line Help for RDII Analyst

Documentation Original Release January 30, 2019
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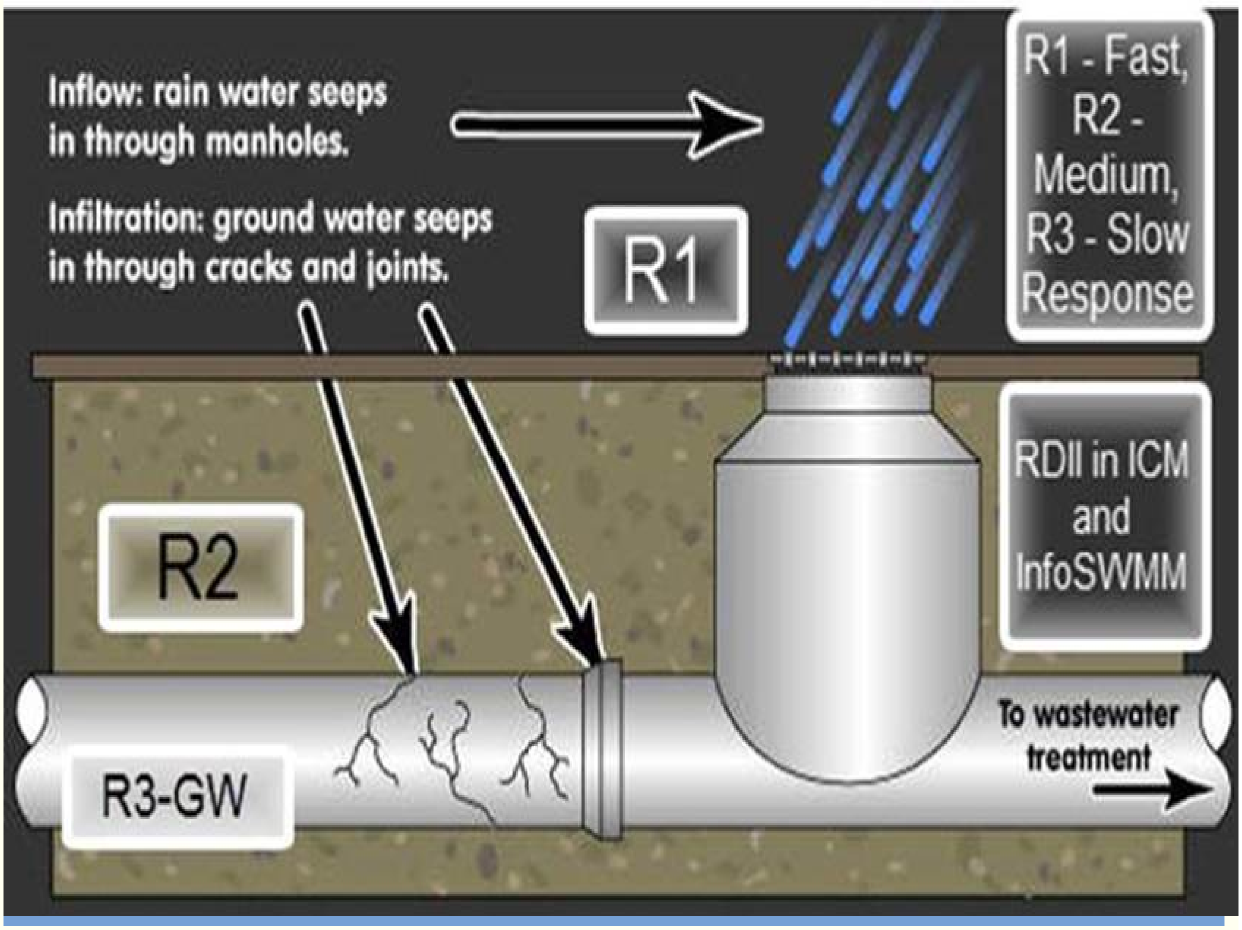
RDII Analyst, SWMM5 and ICM SE - Diagram of R, T and K parameters for RDII

RDII Analyst, SWMM5 and ICM SE - Diagram of R, T

and K parameters for RDII. RDII Analyst in #InfoSWMM

can export using the SWMM5 Export Exchange tool SWMM5 files with calibrated RTK parameters for #SWMM5 and #InfoWorks_ICM



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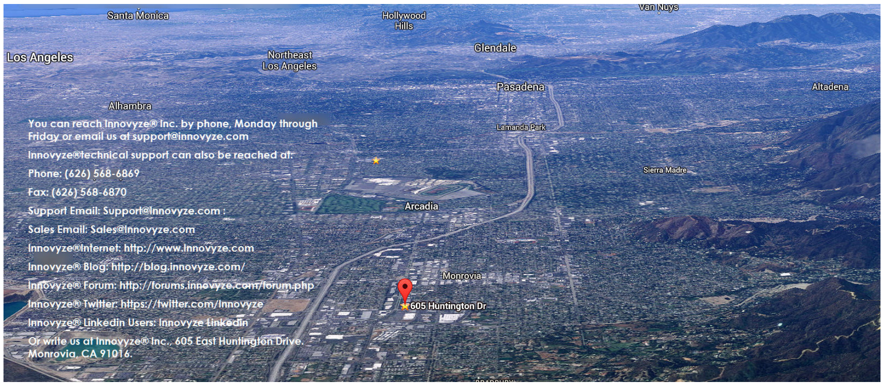
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Pasadena
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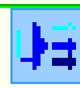
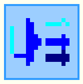
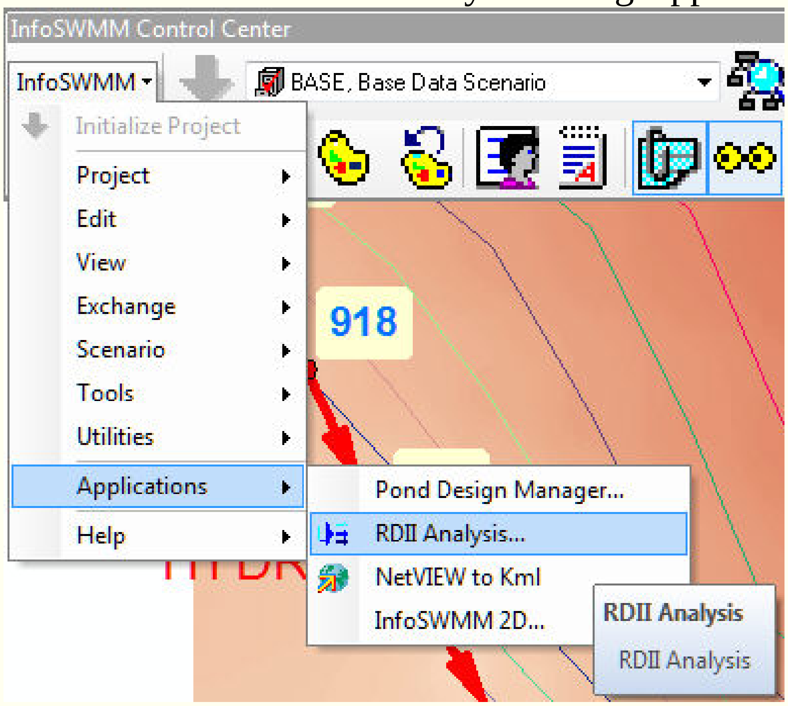
RDII Analyst - Dialog Box 

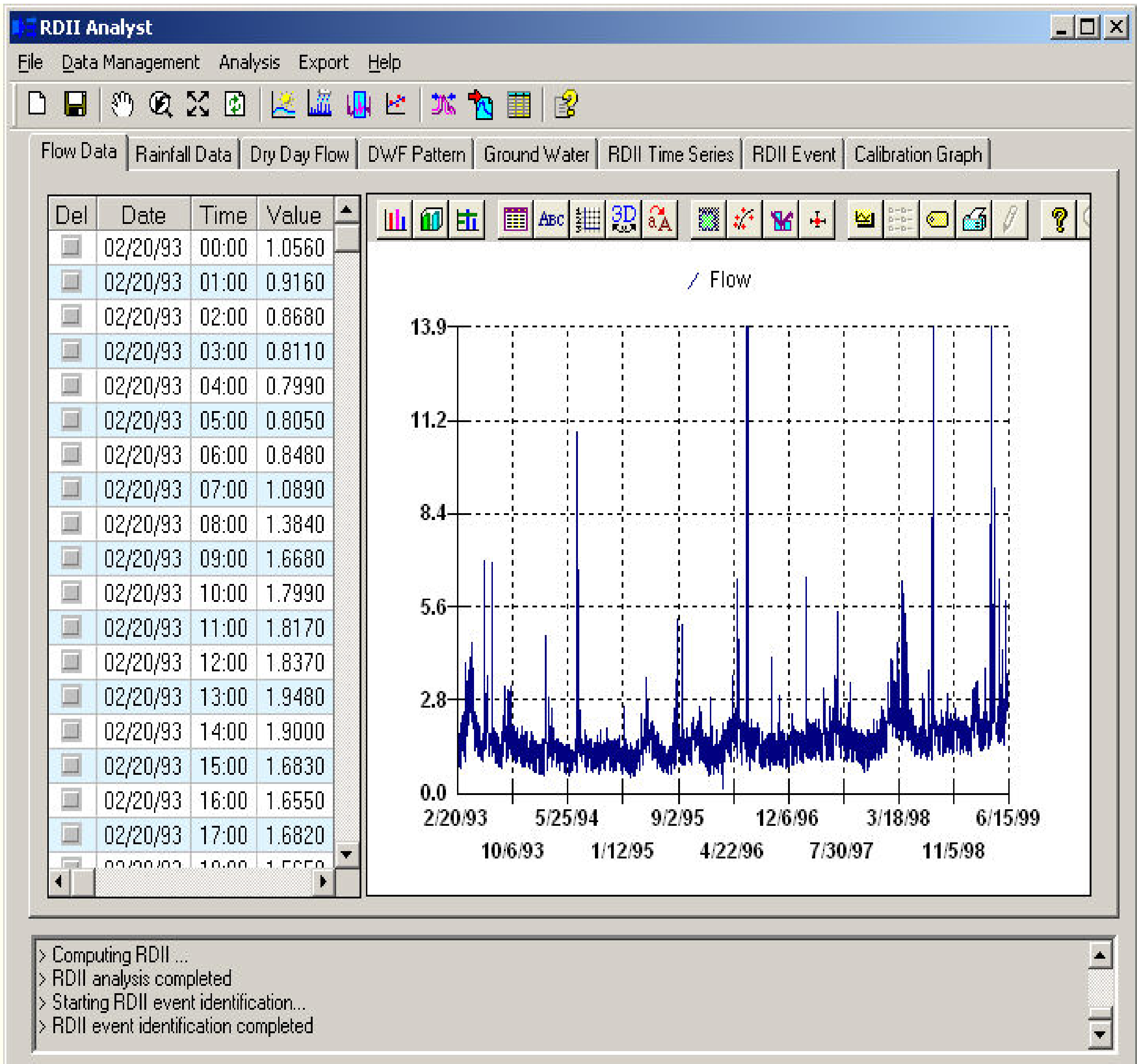
The RDII Analyst  interface, shown below, consists of menus, tool bars, and buttons that are created to simplify various analysis processes. RDII Analyst

can be launched from the main menu by selecting Application> RDII



Analyst>

Click on some areas of the image below for additional information:



- Main Menu: The

  Main Menu provides access to all of the commands and functions of the RDII Analyst.

- Tool Buttons:

  The Tool Buttons provide a shortcut to the functions included in the Main Menu.

- Graph and Report Tabs:

  The Graph and Report Tabs at the top of the dialog box provides a text and graphic display of the input and output data of the RDII Analyst.

To begin a new RDII Analysis, select the New ( ) Tool Button or select the File> New> command from the Main Menu.

This will take you to the New Analysis Dialog Box where you will define the meter that you would like to analyze.

See Also

Main Menu, Tool Buttons, Graph and Report Tabs, New Analysis Dialog Box

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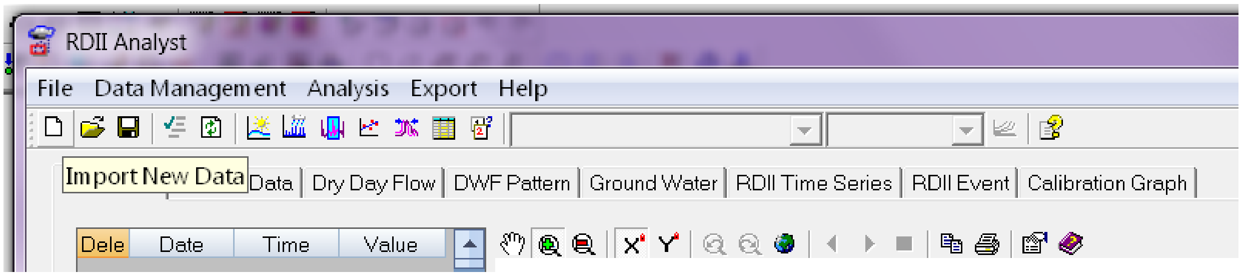
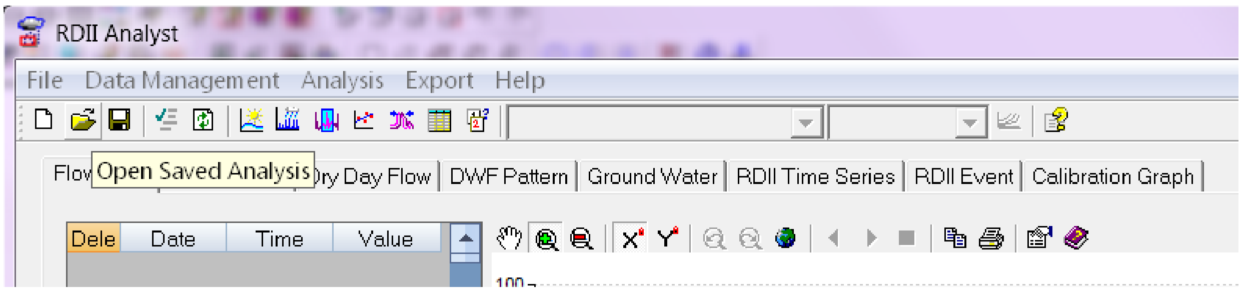
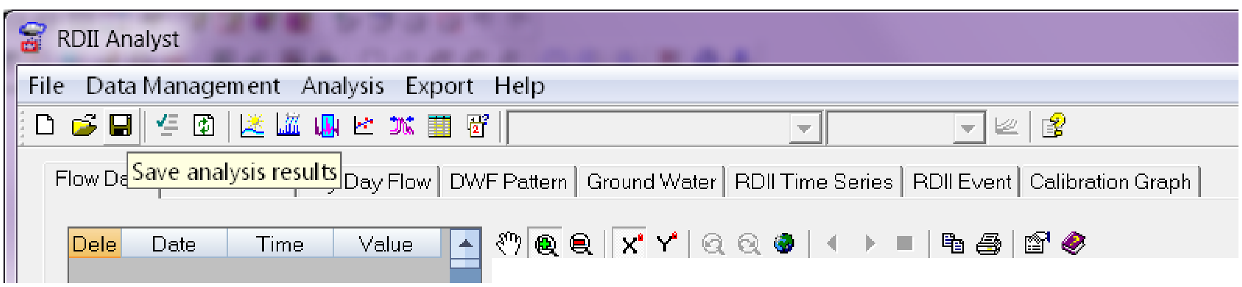
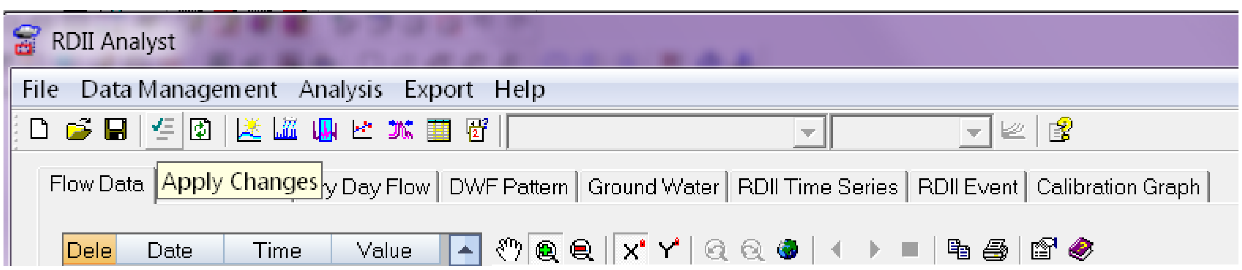
Tool Buttons

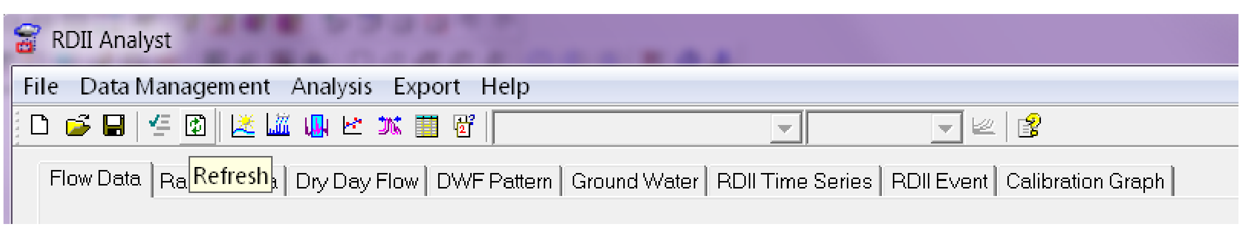
The RDII Analyst toolbar buttons provide the following functions:












RDII Analyst
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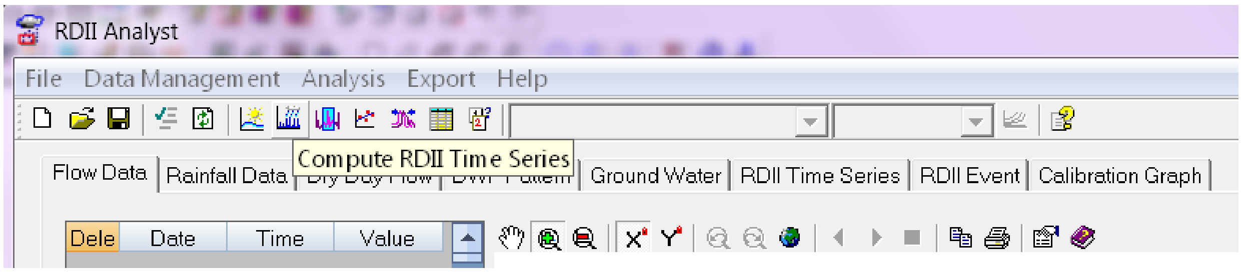
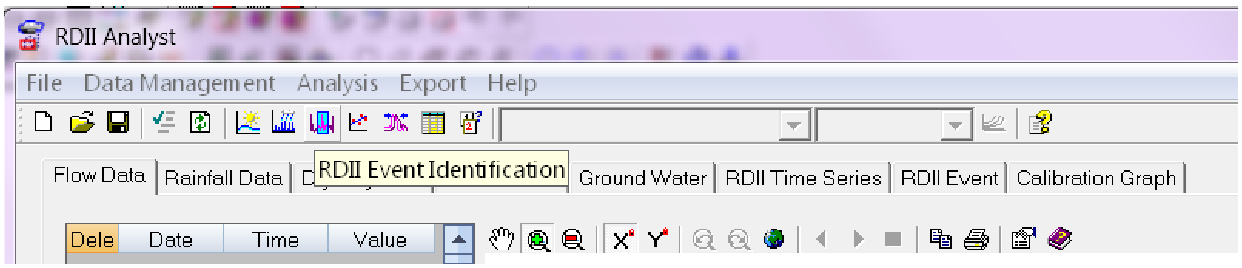
Extract DWF
Flow Data
Rainfall D
Flow
DWF Pattern
Ground Water
RDII Time Series
RDII Event
Calibration Graph
Dele Date Time Value


RDII Analyst
File Data Management Analysis Export Help
Compute RDII Time Series
Flow Data
Rainfall Data
Ground Water
RDII Time Series
RDII Event
Calibration Graph
Dele Date Time Value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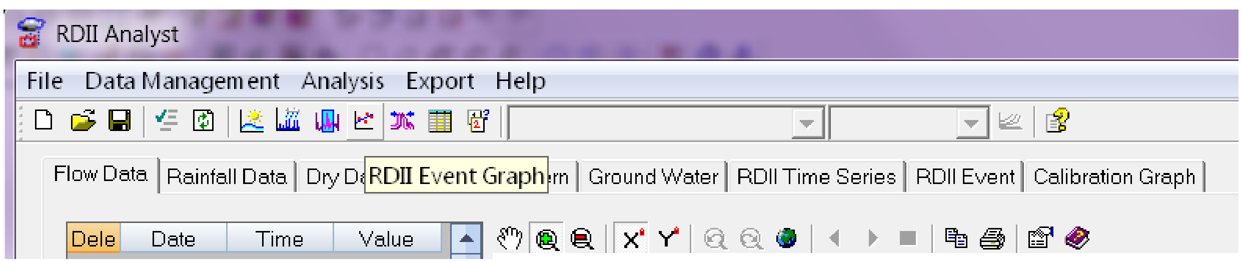
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RDII Event Graph
Flow Data
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Ground Water
RDII Time Series
RDII Event
Calibration Graph
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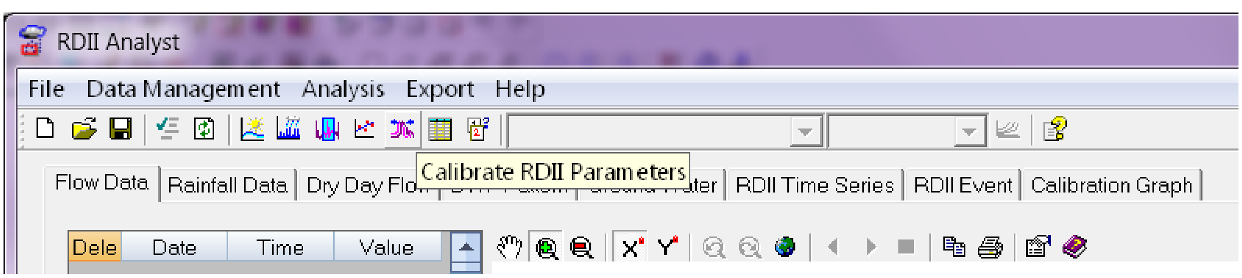
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File Data Management Analysis Export Help
Calibrate RDII Parameters
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RDII Time Series
RDII Event
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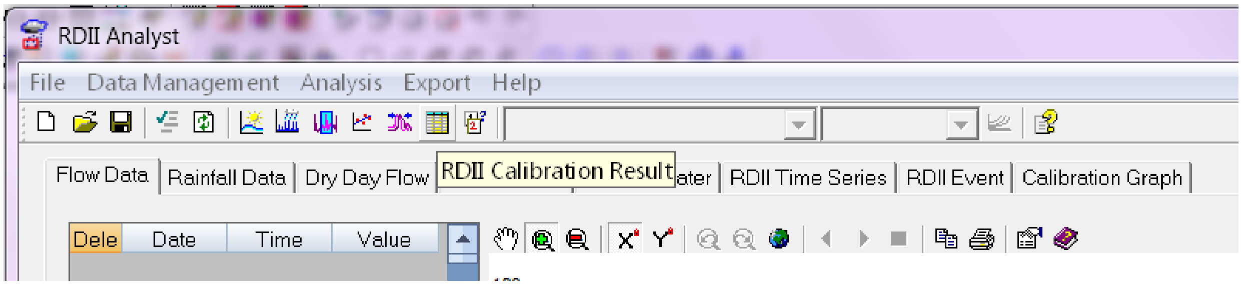
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File Data Management Analysis Export Help
Flow Data Rainfall Data Dry Day Flow
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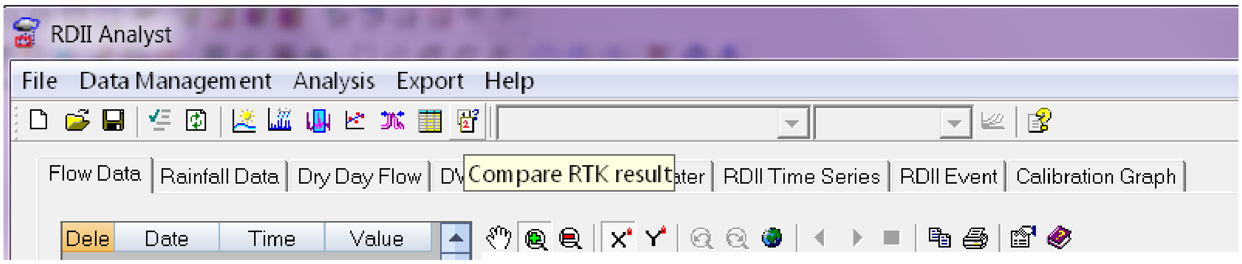
Dele Date Time Value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Flow Data Rainfall Data Dry Day Flow DV
Compare RTK result
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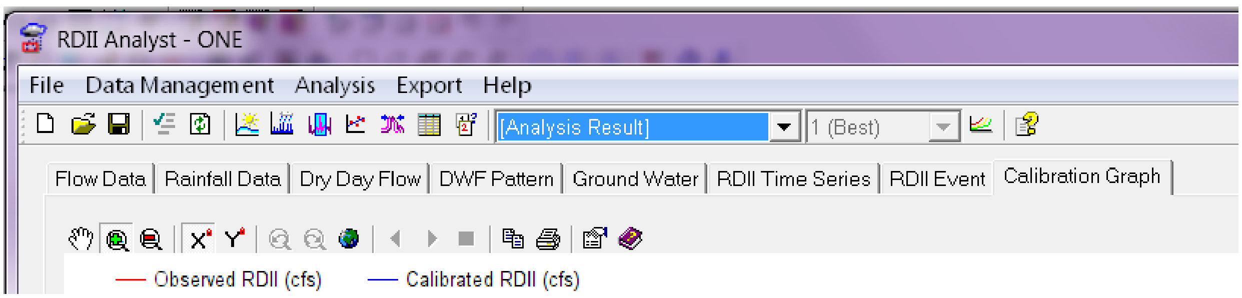
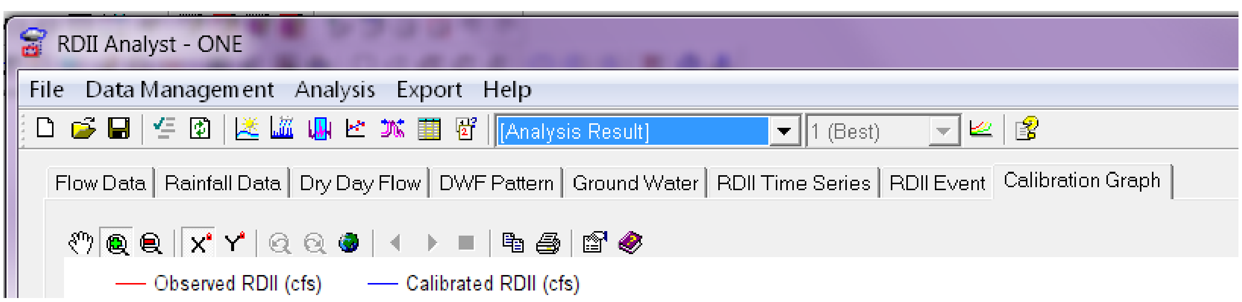
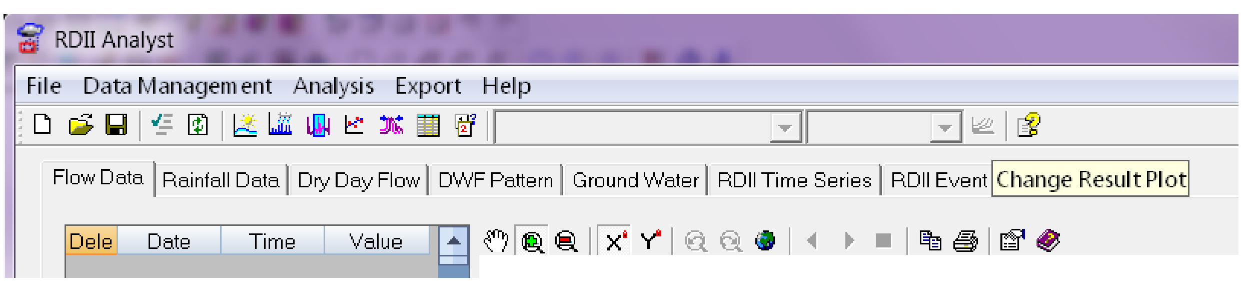
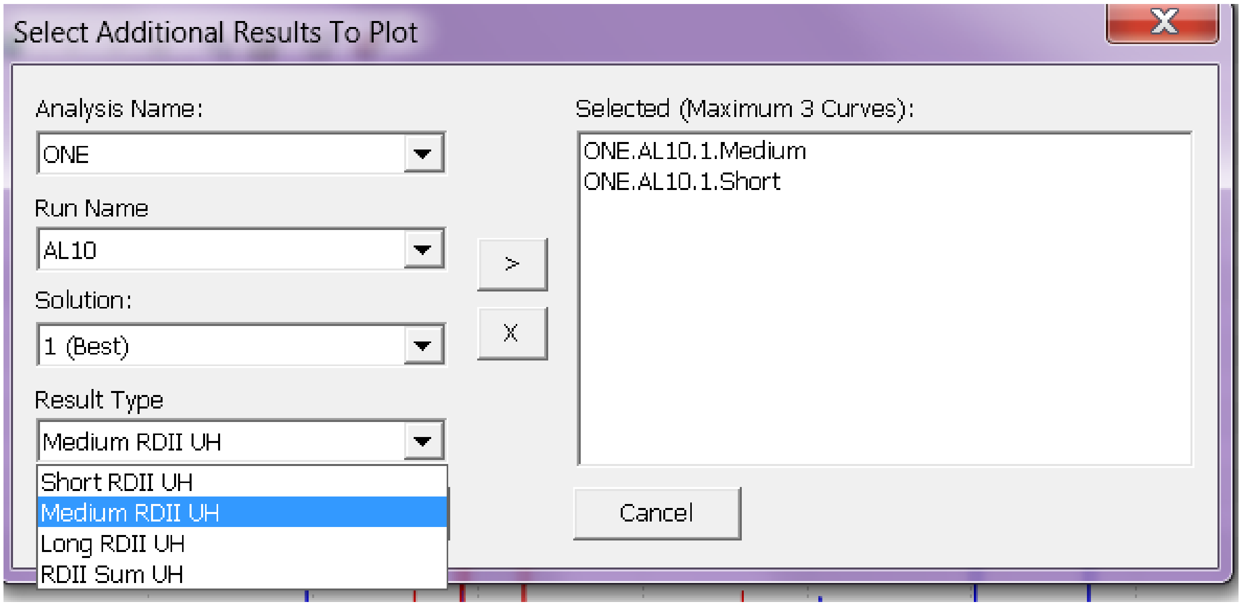
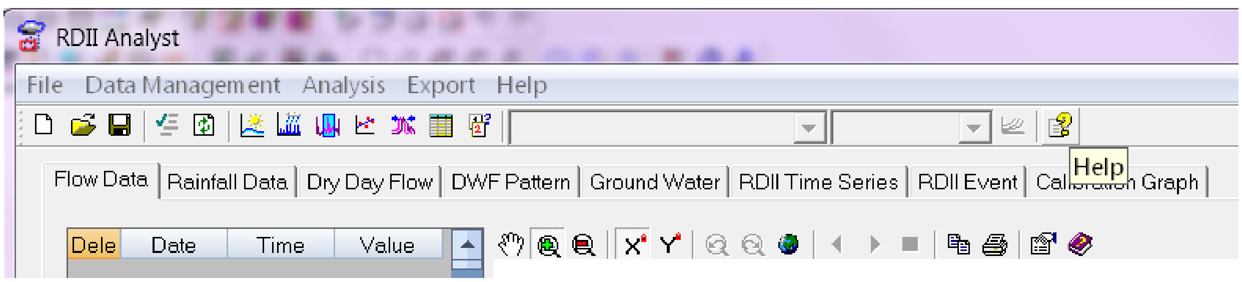
Dele Date Time Value


RDII Analyst - ONE
File Data Management Analysis Export Help
[Analysis Result]
1 (Best)
Flow Data Rainfall Data Dry Day Flow DWF Pattern Ground Water RDII Time Series RDII Event Calibration Graph
Observed RDII (cfs)
Calibrated RDII (cfs)


RDII Analyst - ONE
File Data Management Analysis Export Help
[Analysis Result]
1 (Best)
Flow Data Rainfall Data Dry Day Flow DWF Pattern Ground Water RDII Time Series RDII Event Calibration Graph
Observed RDII (cfs)
Calibrated RDII (cfs)

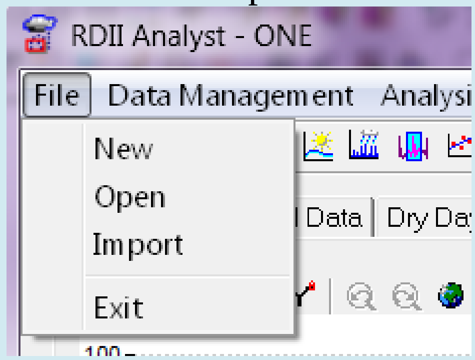
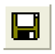
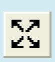
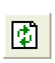

RDII Analyst
File Data Management Analysis Export Help
Flow Data Rainfall Data Dry Day Flow DWF Pattern Ground Water RDII Time Series RDII Event
Change Result Plot
Dele Date Time Value

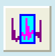
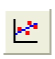
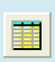




Brief description of the tools/buttons available from this tool bar is given below.

Button	Name	Description
	**New**	Is used to create new RDII analysis project. It will launch the dialog box used to define new flow data and rainfall data files. The New Button launches the New Analysis Dialog Box where new flow and rainfall data file

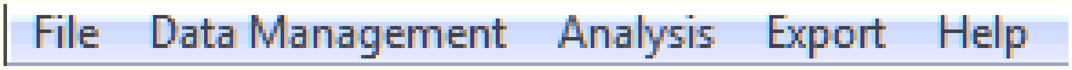
		locations are input. 
	**Save**	Is used to save changes made to the flow data and the raingage data tables in the Flow Data Tab and the Rainfall Data Tab back to the respective data base files. **Note**: Saving changes will invalidate the current results and the current analysis, if any, will need to be rerun.
	**Pan**	Is used to move across the graphs time axis and helps to better visualize the data values. A Graph Control Toolbar is also provided to manage the graph display.
	**Zoom Previous**	Zooms to previous view of graph.
	**Zoom to Full Extent**	Zoom the graph to the full extent of the data
	**Refresh**	Refreshes the graphs based on the latest changes made to the data
	**DWF Extract**	Extracts the DWF component from the flow data. It is also accessible from the Main Menu with the Analysis> DWF Extraction command. See the Analysis Menu. This tool button starts the Dry Weather Flow Extraction process See: DWF Extraction for more information

	**Compute RDII Time Series**	Extracts the RDII Time Series from the Flow data the DWF time series and the GWI time series determined from previous steps. It is also accessible from the main menu with **Analysis> RDII Analysis> Compute Time Series>**. See the Analysis Menu for additional information.
	**RDII Event Identification**	Launches the RDII Event Identification dialog box to set the parameters to calculate the Event Graph. A linear regression between the RDII Depth and the Rainfall Depth will displayed. This command is accessible from the main menu with the Analysis> **RDII Analysis> Event Identification>** command. See: RDII Event Identification
	**Event Graph**	Displays a graph showing the linear regression between RDII volume and rainfall volume for RDII events identified using RDII Analyst. Displays the results of the **Analysis> RDII ANalysis> Event Identification>** analysis. See: Event Graph
	**RDII Calibration Parameters**	Launches the RDII calibration parameters dialog box to define the RTK parameter ranges and sewershed area for the tributaries. See: RDII Calibration Parameters
	**Calibration Report**	Launches the Calibration Report dialog box. This button shows the results of the Calibrate RDII Parameters analysis. See RDII Calibration Parameters
	**Help**	Launches this online help file

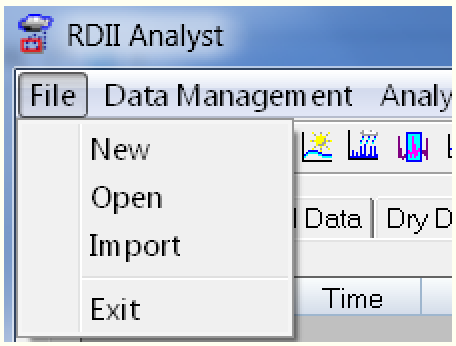
InfoSWMM

Main Menu

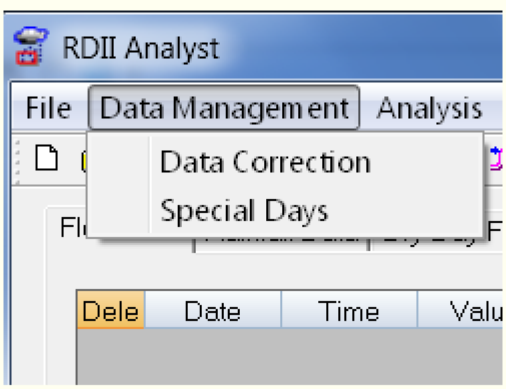
The main menu provides access to all of the RDII Analyst's functions.

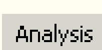


Use the File options to begin a new analysis process or use Exit to close the RDII Analyst. See: File Menu

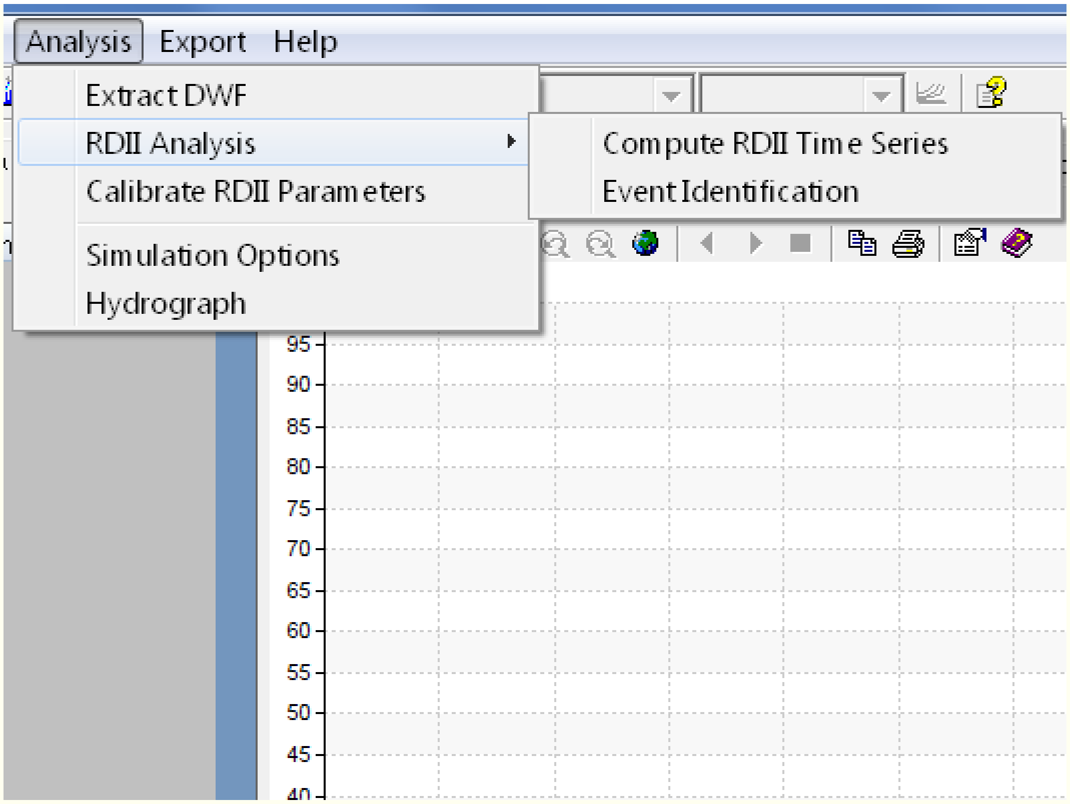


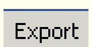
The functionality under this menu is used to perform QA/QC of the flow data and the rainfall data. The Data Correction option is used to edit/delete suspicious data values and flow data corresponding to special days such as holidays. See: Data Management Menu





The features provided in this menu help to decompose the corrected flow data into dry weather flow (DWF), groundwater (GWI) and RDII flow. Calibration of the RTK parameters can also be launched from this menu. See: Analysis Menu

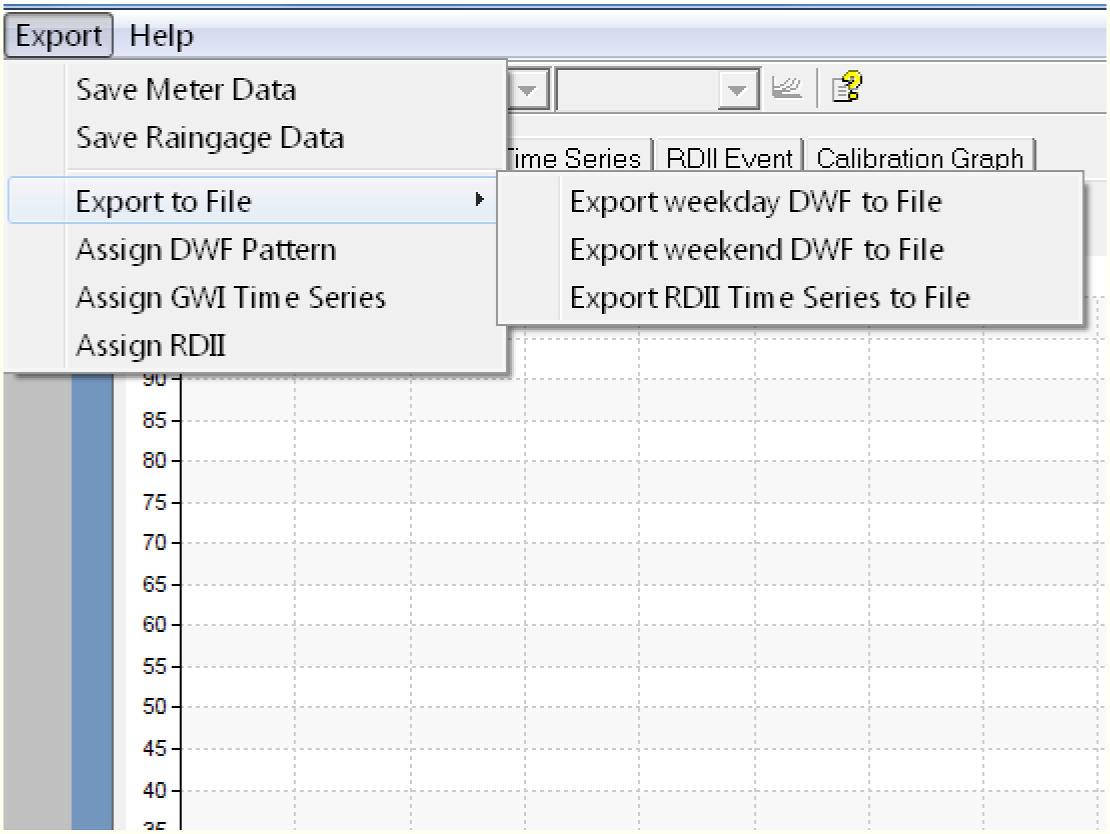




The export menu may be used to export the extracted DWF, GWI and RDII time series to Innovyze RDII Analyst and to assign these flow types to the nodes that contribute flow to the meter location. Some analysis results can also be exported to text file.

The exported flow types may be used to model the collection system using Innovyze RDII Analyst

. See: Export Menu



Help The help menu is used to access the help file that describes how to use the RDII Analyst functionality. See: Help Menu

---

See Also

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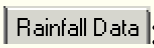
Graphs and Reports

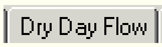
The Graph and Report tabs across the top of the RDII Analyst provides access to the reports and graphs shown below.

Use the hyperlinks to view more detailed information about each tab.

: Presents the flow data in report and graph form. See: Flow Tab.



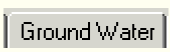
: the rainfall data in graph and report form. See: Rainfall Data Tab.



: Presents the DWF flow time series in graph and report form. See: Dry Day Flow Tab.

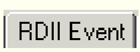
: Presents hourly DWF patterns for weekdays and weekend in graph and report form. See: DWF

Pattern Tab.



: Presents GWF times series in report and graph form. See: Ground Water Tab.

: Presents RDII time series in graph and report format. See: RDII Time Series Tab.



: Presents RDII event information in report format. See: RDII Event Tab.

: Provides graphical comparison of the RDII time series extracted by the RDII analysis from the flow data and the RDII flow simulated by the model based on the calibrated RDII unit hydrograph parameters. See: Calibration Graph Tab.

See Also

Flow

Tab

Rainfall Data Tab.

Dry Day Flow Tab

DWF

Pattern Tab

Ground Water Tab

RDII Time Series Tab

RDII

Event Tab

Calibration Graph Tab

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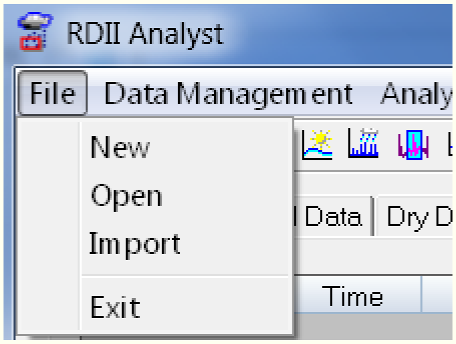
File Menu



Use the New option to define

flow data and rainfall data and to begin decomposition process. See: New Analysis Dialog Box

Use Exit to close the RDII Analyst.

See Also

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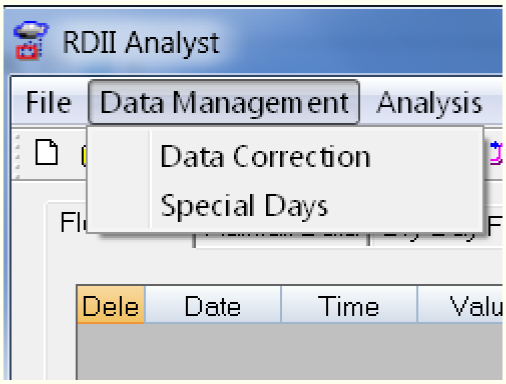
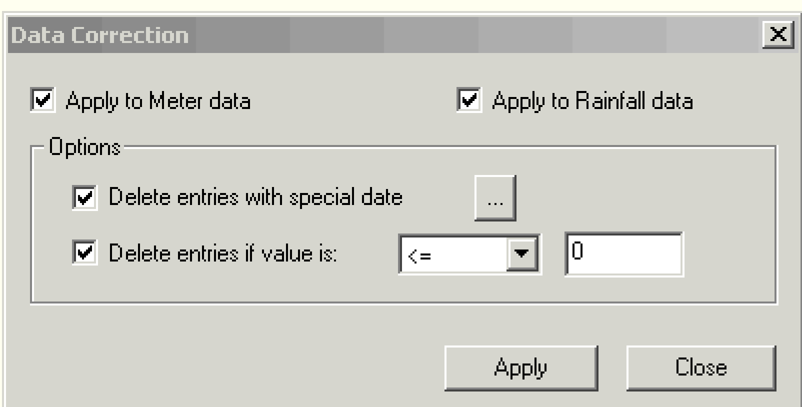
Data Management Menu

The functionality under this menu is used to perform QA/QC of the flow data and the rainfall data. The Data Correction option is used to edit/delete suspicious data values and flow data corresponding to special days such as holidays.

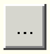


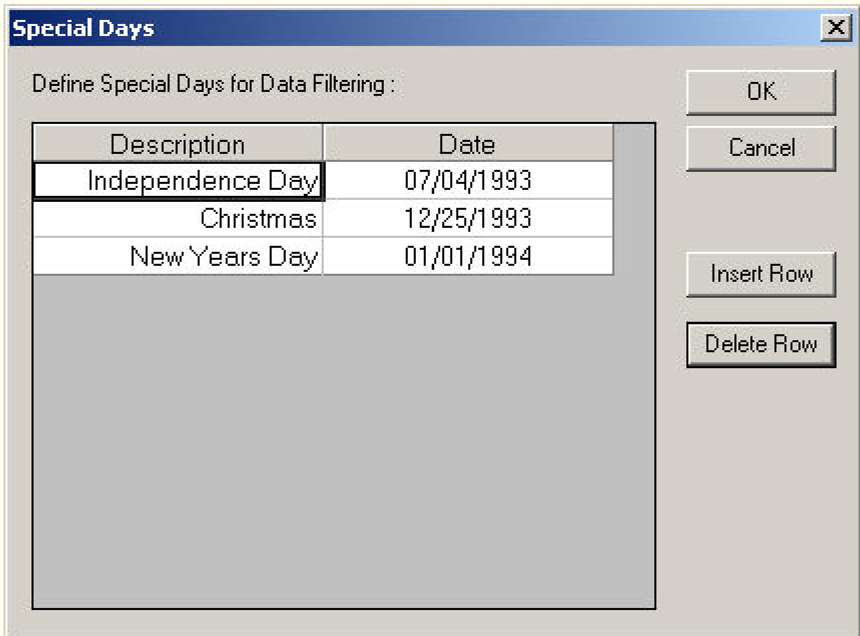
Data Correction: The flow data

and the rainfall data read into RDII Analyst may be corrected using the DATA CORRECTION feature available from DATA MANAGEMENT menu. In addition to the data correction options described below, the user can manually edit/delete data rows as needed and save the changes. See: Data Correction



RDII Calibration Parameters: Special dates such as holidays, which do not represent typical DWF days, may also be removed from the data. Use the Special Days Editor to enter a list of non-typical days to be ignored.

The Special Days Editor can be accessed from the RDII Analyst main menu with the Data Management> Special Days> command or directly from the Browse  button of the Data Correction function. See: Special Days Editor



[See Also](#)

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Special Days Editor

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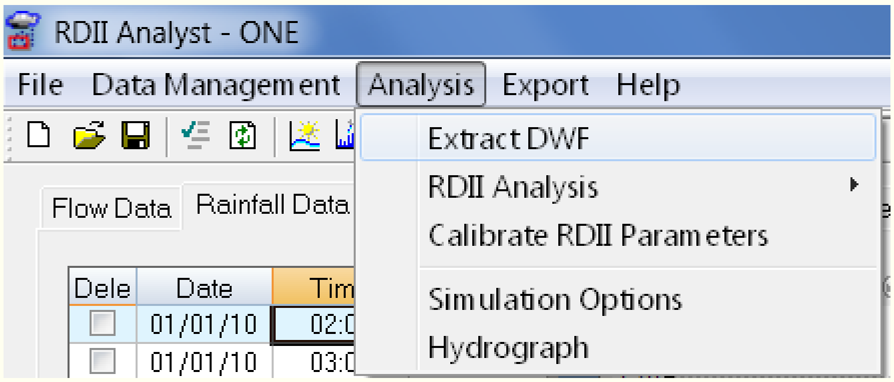
Analysis Menu

The features provided in this menu help to decompose the corrected flow data into dry weather flow (DWF), groundwater (GWI) and RDII flow. Calibration of the RTK parameters can also be launched from this menu.



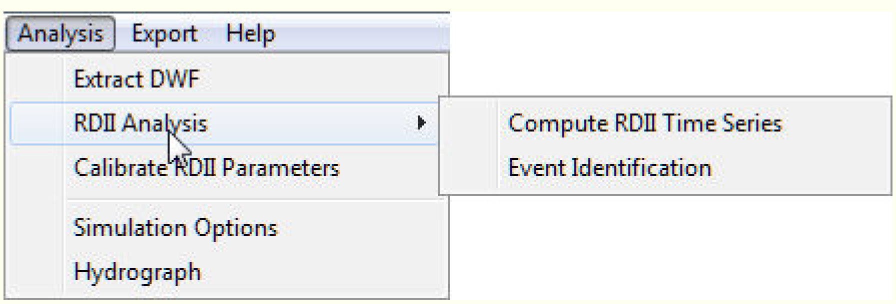
- Extract DWF: Starts

  the Dry Weather Flow process. To extract the groundwater flow component, you need to check the Extract Groundwater Flow option and then assign a value for Fraction of the minimum weekly flow contributed by ground water. See: DWF

  Extraction

- RDII Analysis: Opens

  the sub-menu below.



- Compute RDII Time Series:

  Starts the RDII Time Series calculation. when analysis is complete the RDII Time Series Tab is displayed. See: RDII Time Series

- Event Identification:

  Opens the RDII Event Identification settings window to start the Event Identification Analysis. See: RDII Event Identification

- Calibrate RDII Parameters:

  Opens the RDII Calibration Parameters window and starts the RDII Calibration process. See: RDII Calibration Parameters

- Simulation Options:

  Opens the Innovyze RDII Analyst

  Simulation Options dialog box to allow you to change the simulation options for use in the RDII calibration process.

- Hydrograph: Opens the Innovyze RDII Analyst

  RDII Hydrograph dialog box to allow you to manually change the RTK

  parameters and check the calibration using those changed parameters

  with the Run Once tool ().

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[RDII Calibration Parameters](#)

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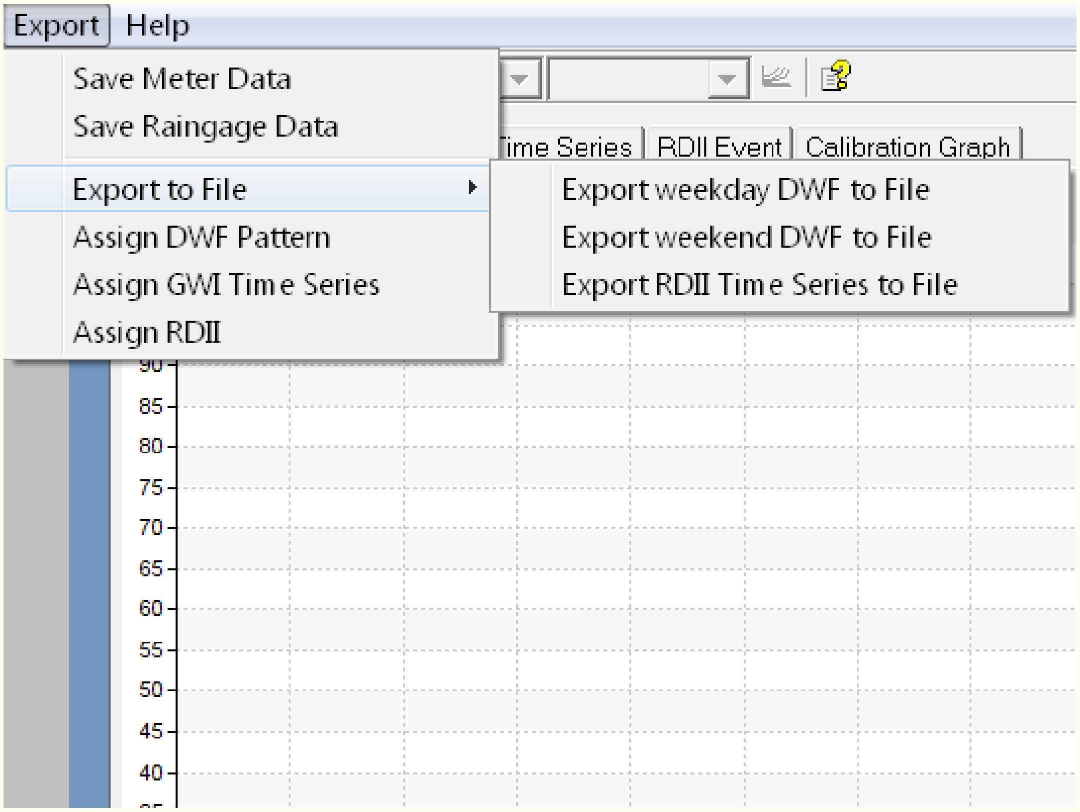
Export Menu

Some of the RDII Analyst results can be exported to text file or to Innovyze RDII Analyst

and can be used to model the collection system. The export tools are available from the Export menu.

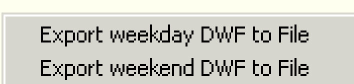


Save Meter Data: This saves the corrected flow monitoring data to a text file for later use.

Save Raingage Data: This function saves corrected rainfall data to a text file for later use.

Export DWF Pattern: This

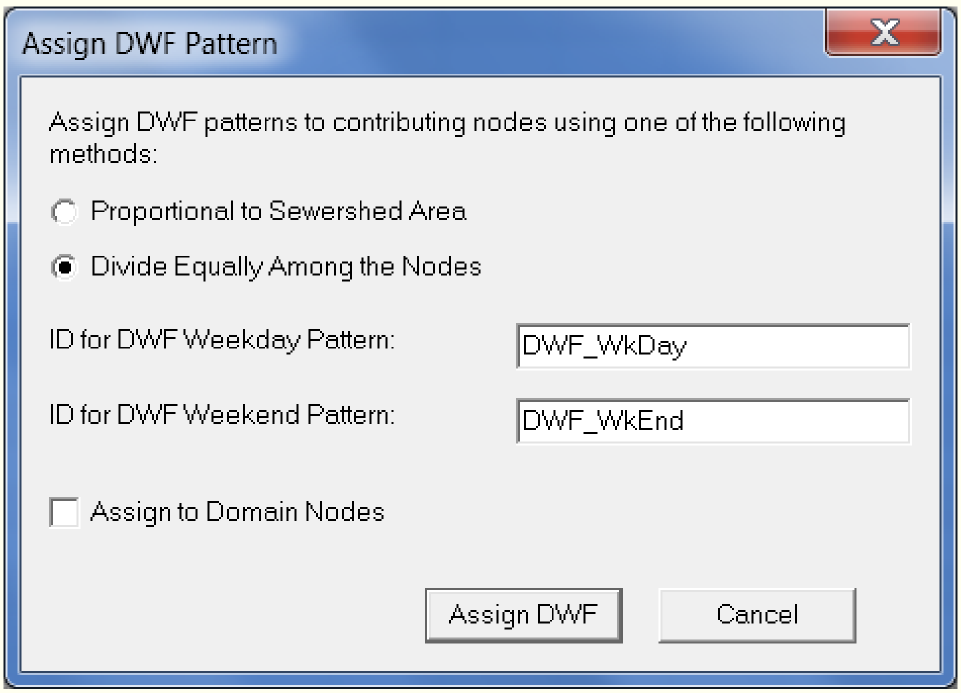
function exports hourly weekday or weekend DWF patterns to a text file.



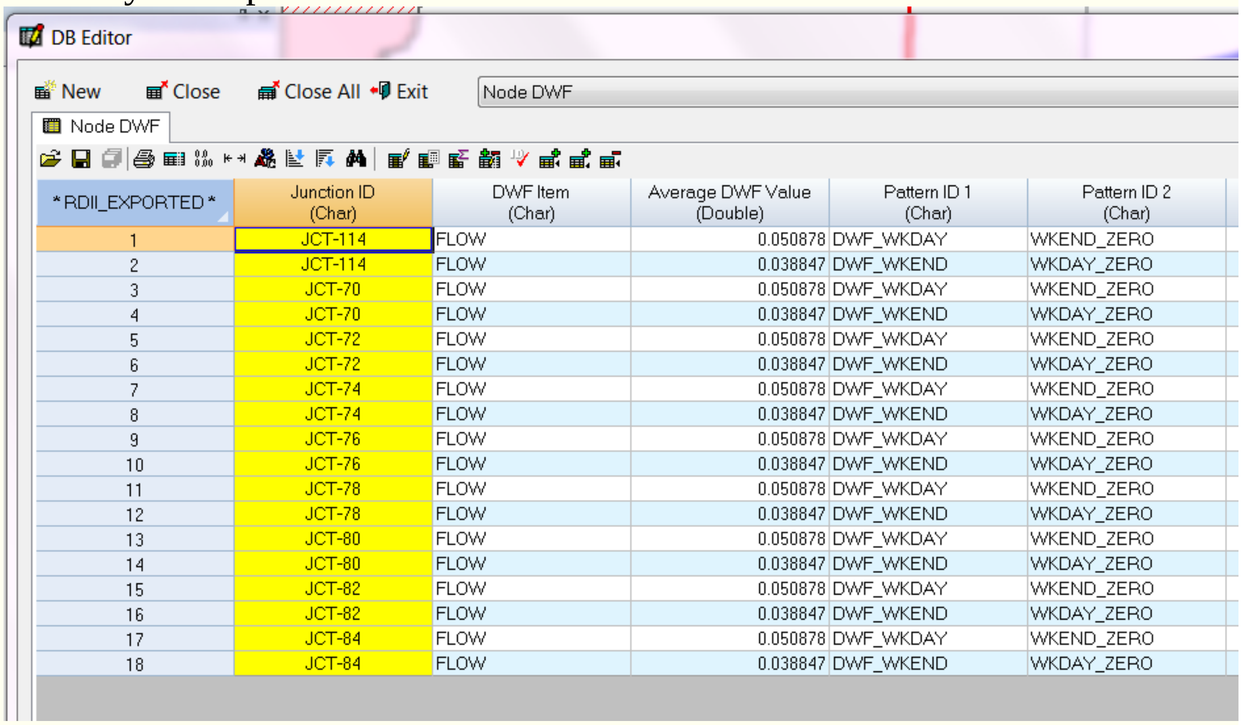
Assign DWF

Pattern: This tool assigns the hourly DWF patterns developed for weekdays and weekends to Innovyze RDII Analyst

nodes that contribute flow to the monitoring site. The DWF pattern is allocated to the contributing nodes either proportional to sewershed area of each contributing node, or simply equally among all contributing nodes. The user must assign an ID to be used as the weekday and weekend pattern name. The assignment could be limited to nodes in a domain by checking the Assign to Domain Nodes option.



The DWF pattern is now exported in to rows for weekday and weekend with a zero pattern for weekend if the row is weekday and a zero pattern for weekday if the pattern is weekend

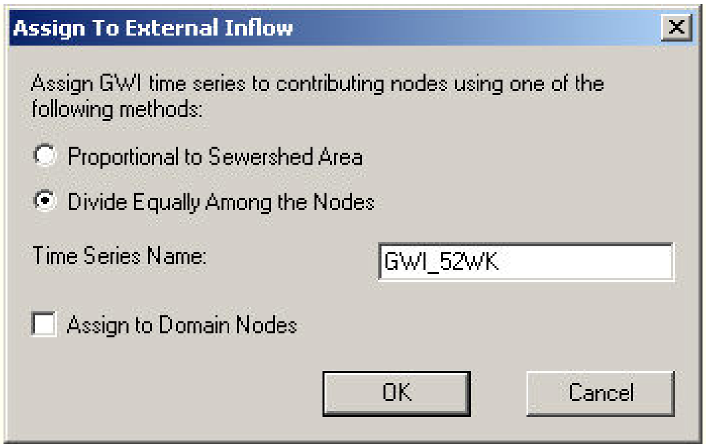


RDII_EXPORTED	Junction ID (Char)	DWF Item (Char)	Average DWF Value (Double)	Pattern ID 1 (Char)	Pattern ID 2 (Char)
1	JCT-114	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
2	JCT-114	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
3	JCT-70	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
4	JCT-70	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
5	JCT-72	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
6	JCT-72	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
7	JCT-74	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
8	JCT-74	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
9	JCT-76	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
10	JCT-76	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
11	JCT-78	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
12	JCT-78	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
13	JCT-80	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
14	JCT-80	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
15	JCT-82	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
16	JCT-82	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO
17	JCT-84	FLOW	0.050878	DWF_WKDAY	WKEND_ZERO
18	JCT-84	FLOW	0.038847	DWF_WKEND	WKDAY_ZERO

Assign GWI

Time Series: This function assigns the groundwater flow time series to Innovyze RDII Analyst

nodes that contribute flow to the monitoring site. The time series is assigned to the nodes as external inflow. The GWF time series is allocated to the contributing nodes either proportional to sewershed area of each contributing node, or simply equally among all contributing nodes. The user must provide a Time Series Pattern name. The assignment could be limited to nodes in a domain by checking the Assign to Domain Nodes option.

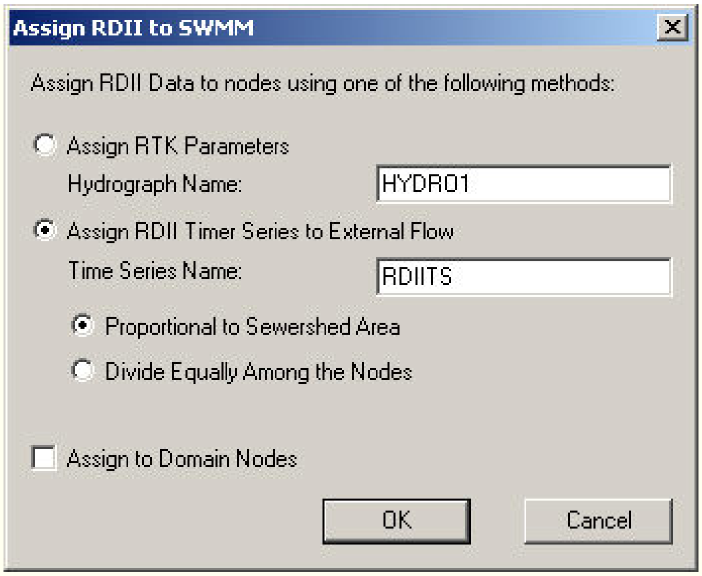


Assign RDII:

This function assigns either the RTK parameters determined by the calibration tool or the RDII time series determined by decomposing the flow monitoring data to Innovyze RDII Analyst

nodes that contribute flow to the monitoring site. The RTK parameters could be exported to Innovyze RDII Analyst

and assigned to RDII hydrographs for each contributing node. The time series is assigned to the nodes as external inflow. The RDII time series is allocated to the contributing nodes either proportional to sewershed area of each contributing node, or simply equally among all contributing nodes. The user must provide a name for the Hydrograph and/or the Time Series. The assignment could be limited to nodes in a domain by checking the Assign to Domain Nodes option. Please note that if both the GWF time series and the RDII time series are exported into Innovyze RDII Analyst , only the time series exported last would be available for use. Innovyze RDII Analyst takes only one external inflow time series at a time.



See Also

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Help Menu

The help menu contains the following components that enables the user to access RDII Analyst's online help and easily locate specific information.

- Content: This enables

  the user to browse the online help through its table of contents.

- Index: The user may

  use the index/keyword of his/her choice to directly locate in the online help the topics related to the key word.

- Technical Support: This links the user to Innovyze(R) Inc.'s technical support URL (i.e., http://www.Innovyze.com/page/ p_support/ support.htm).

- Innovyze(R) on the Web: This links the user either to Innovyze(R) Inc.'s home page (i.e., http://www.Innovyze.com/), or to Innovyze(R)

  Inc.'s URL where the user can download the latest updates available on the products of the company.

- About RDII Analyst:

  This sub-menu contains general information about RDII Analyst. Specifically, essential information such as licence and copyright agreement.

See Also

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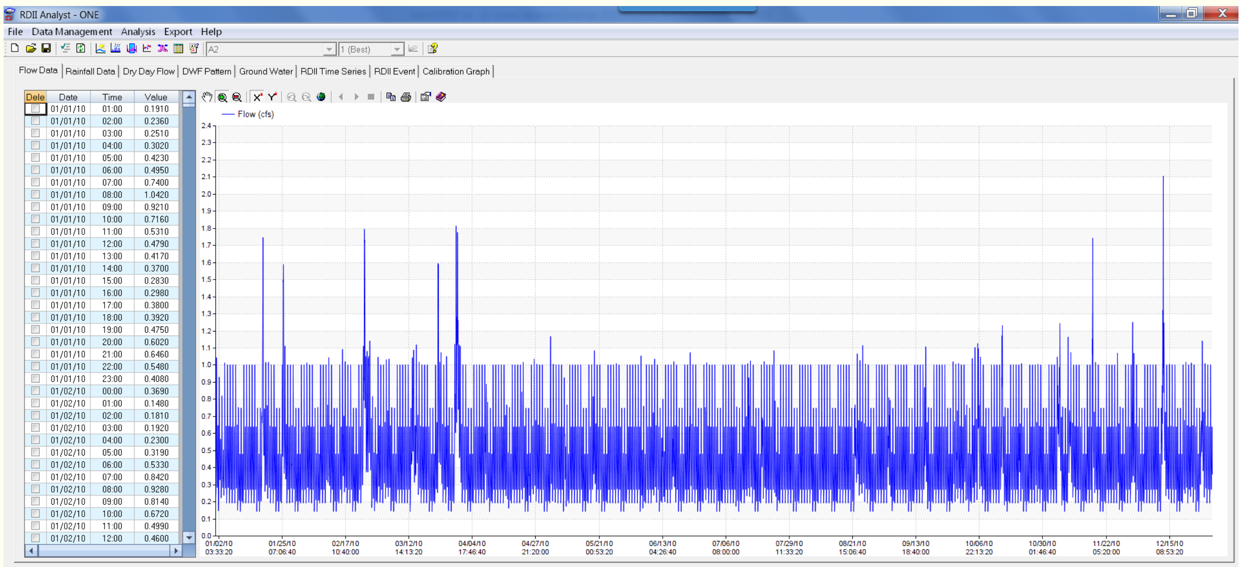
Flow Data Tab

The Flow Data Tab displays the flow data that has been read from the flow data file. The display consists of the data area showing Date Time and Value field that is read from the data file (See: New Analysis Dialog Box). Values in the data file may be edited by typing over the values shown or deleted by selecting the delete button on the left. The graph portion of the Flow Data Tab displays the tabular data in graph format. It shows the recorded flow values over time. A Graph Control Toolbar is provided to manage the graph display.



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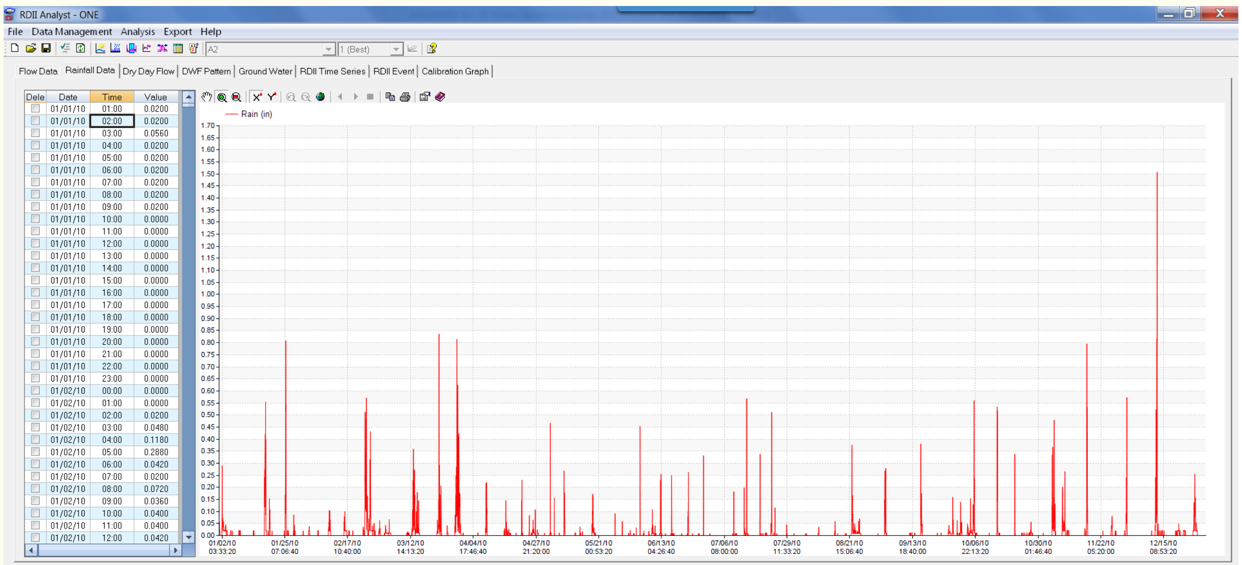
Rainfall Data Tab

The Rainfall Data Tab displays the flow data that has been read from the rainfall data file. The display consists of the data area showing Date Time and Value field that is read from the data file (See: New Analysis Dialog Box). Values in the data file may be edited by typing over the values shown or deleted by selecting the delete button on the left. The graph portion of the Rainfall Data Tab displays the tabular data in graph format. It shows the recorded rainfall values over time. A Graph Control Toolbar

is provided to manage the graph display.



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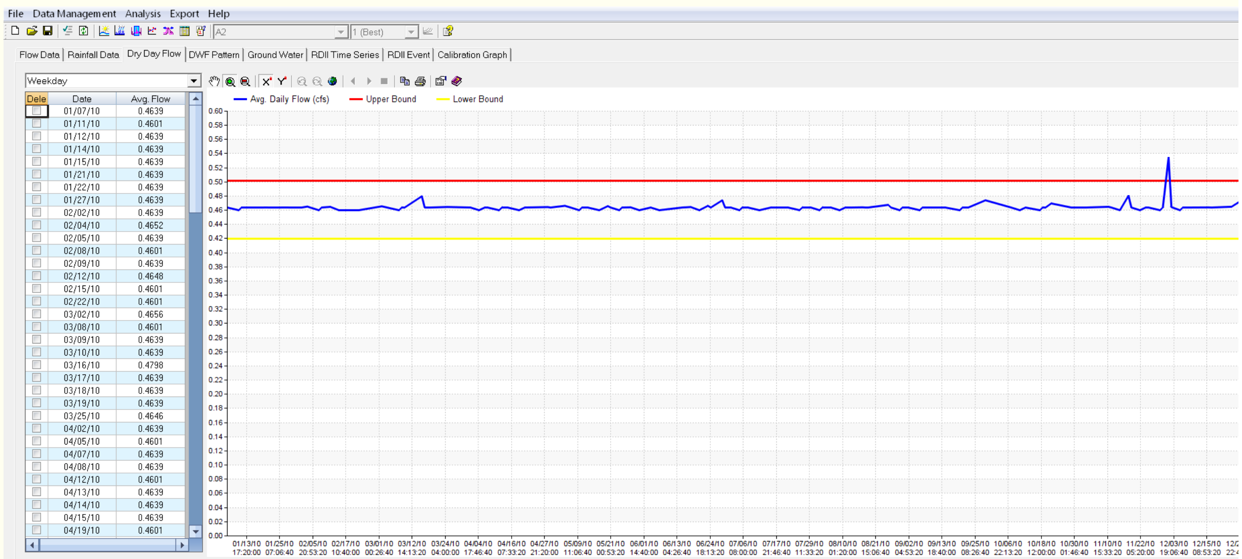
Dry Day Flow Tab

Once determined, the dry days flows are presented both in report form and in graph form for weekend and for weekdays as shown below. The graph shows average daily flow for each dry day, and upper bound and the lower bounds. The upper bound refers to mean flow of all dry day flows plus standard deviation multiplier *standard deviation of dry day flows. The lower bound refers to mean flow of all dry day flows minus standard deviation multiplier *standard deviation of dry day flows. The bounds help the user visually identify outliers and, if necessary, discard those days from further consideration.



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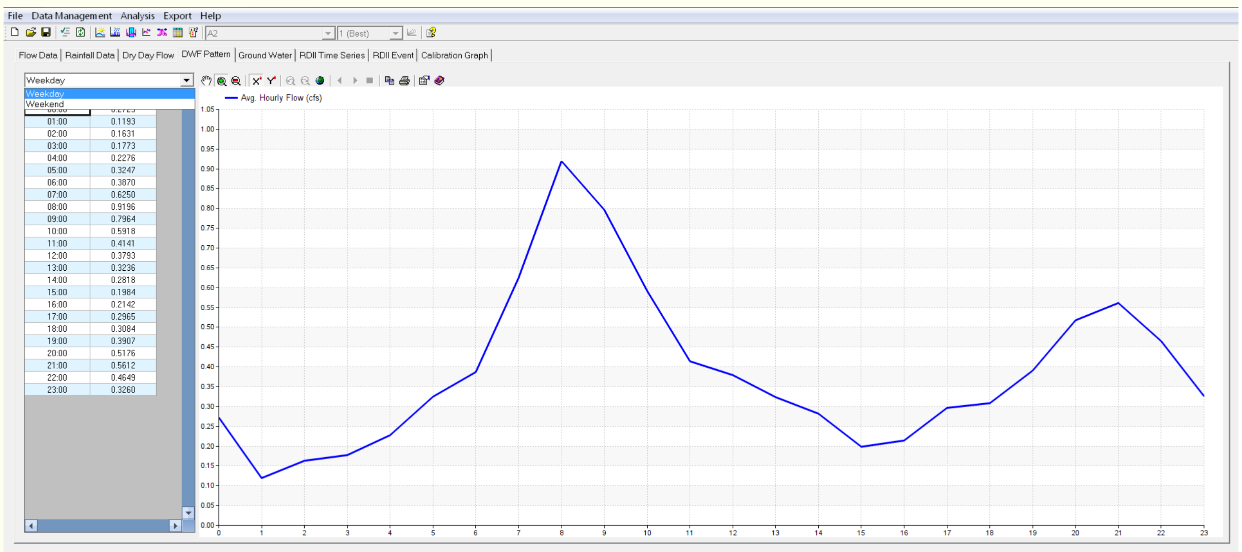
DWF Pattern Tab

The dry day flows identified for weekdays and the weekend are further analyzed to determine hourly DWF patterns that can be used to model DWF in Innovyze RDII Analyst. The DWF pattern presents average hourly DWF values across all dry days for both weekdays and weekend. The DWF pattern is given both graphically and in report form as shown below.

The DWF patterns can be exported to Innovyze RDII Analyst and are assigned to nodes that contribute flow to the meter location proportional to sewershed area or equally among all nodes.



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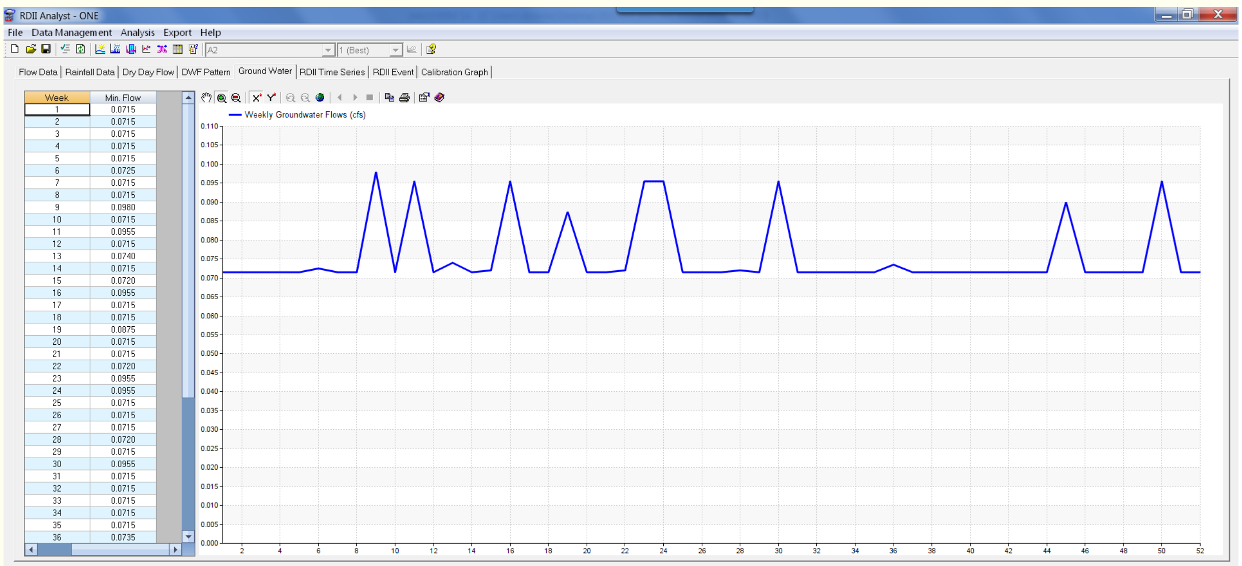
Ground Water Tab

The groundwater flow time series can be exported to Innovyze RDII Analyst as external inflow and can be assigned to nodes that contribute flow to the meter location proportional to sewershed area or equally among all nodes.

Once the Ground Water Analysis is complete, GWI component is presented graphically and in report form as shown below.



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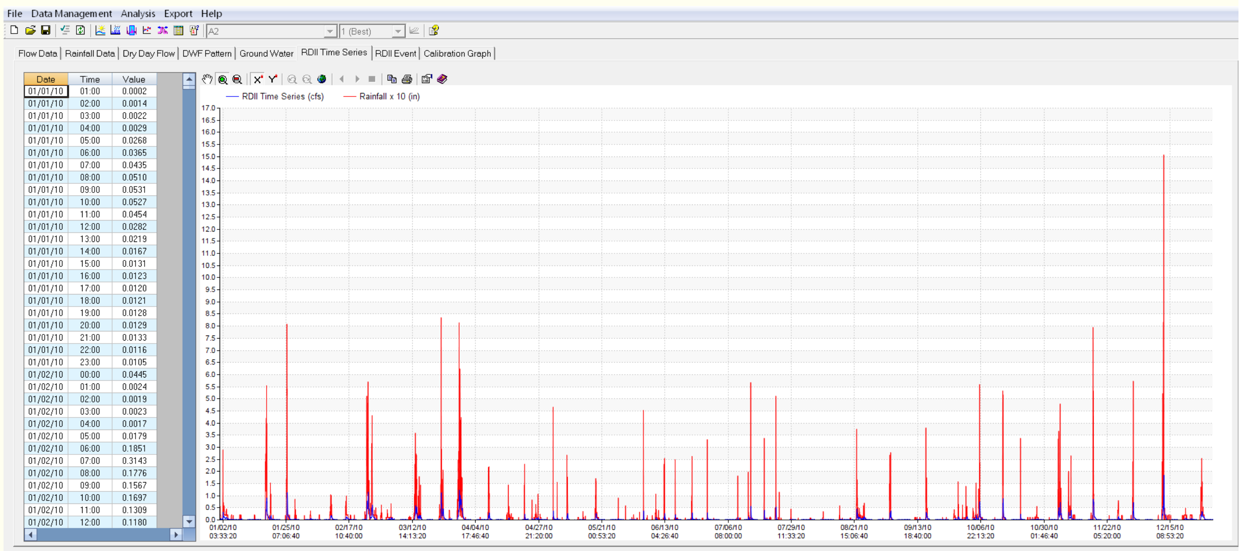
RDII Time Series Tab

RDII flow is the difference between the corrected monitoring flow data, and the sum of average hourly DWF pattern and the groundwater flow time series. Once the hourly DWF pattern and the groundwater flow components are identified, the sum of the two components would be subtracted from the corrected flow data to determine the RDII flow component. Determination of RDII time series can be launched using the Tool Button or from the Main Menu

using Analysis -> RDII Analysis ->

Compute RDII Time Series.



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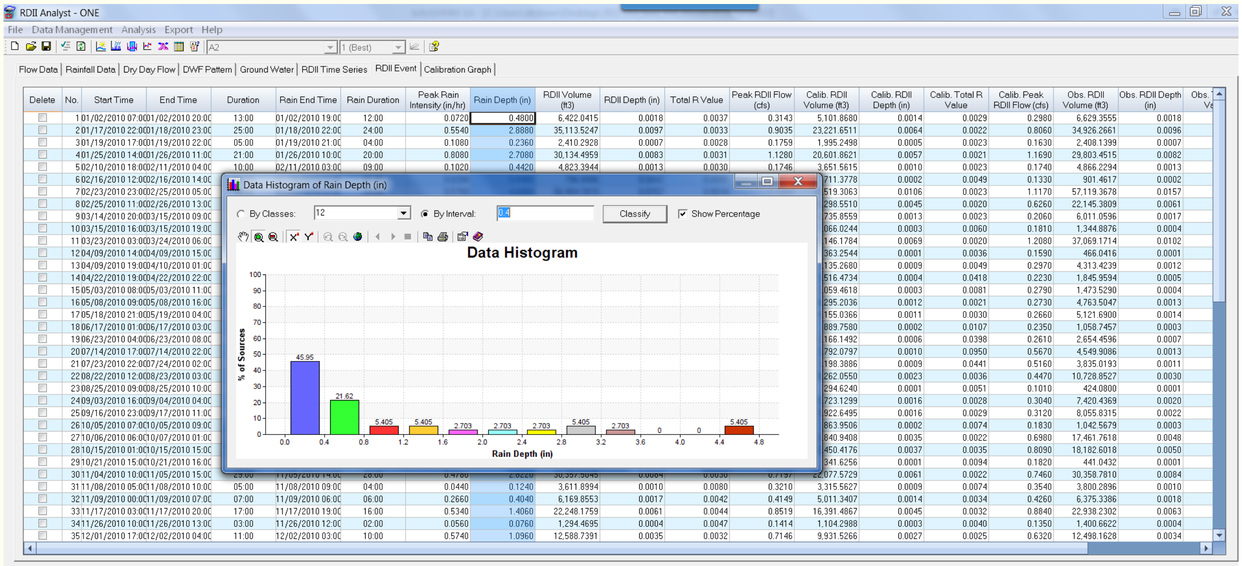
RDII Event Tab

The identified RDII events are summarized as shown below.



The Linear Regression of the above results are summarized in the Event Graph.

The above screen may be expanded to show the full extents of the RDII Event Analysis.

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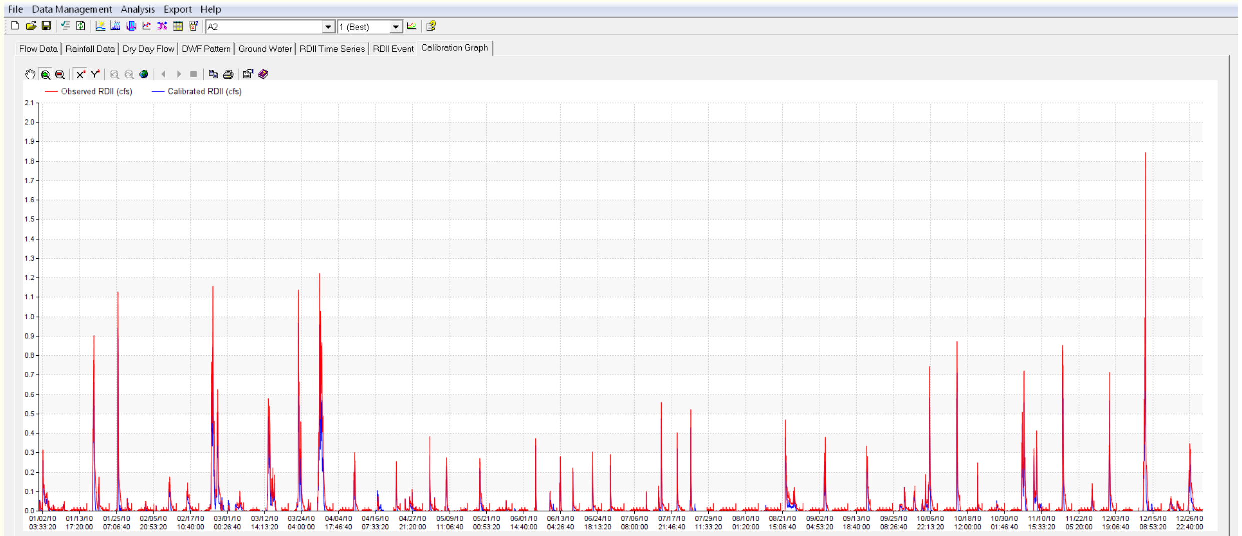
Calibration Graph Tab

Graphical comparison of the RDII flow generated by the calibrated parameters and the RDII time series generated by the decomposition process is provided to visually analyze the calibration results.



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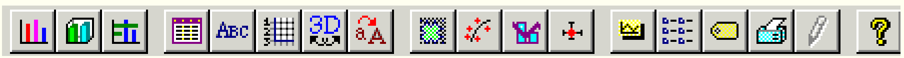
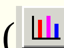
Graph Control Toolbar

Graph Modification Buttons

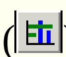
The following functions are available for customizing the graph display.

If you do not see one or more of the following buttons while a graph is being displayed, that function is not available for the currently displayed graph type.



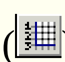
2D Graph Gallery (): Select a two-dimensional graph display format. The most commonly-used 2D formats include Line, Bar, and Area. Other formats may not be applicable to the data shown on your graph.

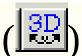
3D Graph Gallery (): Select a three-dimensional graph display format. The most commonly-used 3D formats include Bar, Tape, and Area. Other formats may not be applicable to the data shown on your graph. Use the 3D Properties button to control the display angle and depth of your 3D graph.

Style (): Choose display elements for 2D graphs. You may choose to display symbols (single X,Y points representing simulation values), lines (showing the trend of the simulation result variable), and/or sticks (extruding simulation values to the X-axis for visual emphasis).

Data (): Modify individual graph data values. This option is useful for manually changing a graph data value.

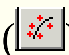
Titles (): Change graphs titles and labels including the main and secondary graph title, X- and Y-axis titles, and the orientation of the axis titles.

Axis (): Modify X- and Y-axis scale, position (left, right, above, or below graph data pane), tic mark intervals, and display pane grid line style and color.

3D Properties (): Modify display properties for 3D graphs including viewing angle, orientation, and depth. You may also select 3D graph wall and edge colors and gaps.

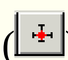
Fonts (): Sets the font used to display information in the graph including graph titles, axes tic mark labels, and graph data value labels. Choose from among the fonts currently loaded on your workstation.

Markers (): Choose the color, pattern, symbol, and/or symbol size, line width, and/or line pattern used to display data on the graph.

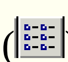
Trends (): Superimpose one or more statistical summary trend lines on the graph display.

Choose from among mean, min/max. standard deviation, best fit, and one of a variety of curve fits including variable-order polynomial and moving averages. You may also specify the color used to display the trend lines you choose.

Overlay (): Specify display characteristics of field-measured data imported with the Import Data button. You may specify observed data display symbol and style, whether or not the observed data will share a common axis with modeled data or have its own axis, and may display statistical trend lines applied to the observed data.

Error Bar (): Superimpose error bars on a graph in either the X or Y dimension. You may display bars of fixed, user-defined values, percent values, standard deviation, or standard error bars. This option is applicable to both standard and group graphs.

Background (): Modify graph background colors, border styles, border colors, and text colors. These properties may be applied to any graph component including titles, graph display pane, and legend. You may choose colors from among a variety of color palettes depending on the display characteristics available on your workstation.

Legend (): Specify legend entry text, legend entry spacing, and legend position relative to the graph display pane.

Labels (): Toggle axis label text and graph data text on and off. Additionally, specify text characteristics such as axis label format and graph data color.

System (): Print or export the current graph display. You may copy the graph display to the Windows Clipboard (choose the Clipboard option and then choose the Copy button) or save the graph to a file in one of several formats (choose the File option, specify a file name, and choose the Copy button).

You may also specify graph template to apply to all graphs.

Edit (): This function is disabled.

Help (): Provides more detailed help on the graphing customization tools.

About Graph (): Displays information about the graphing function.

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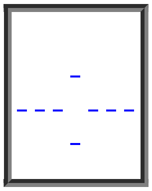
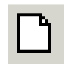
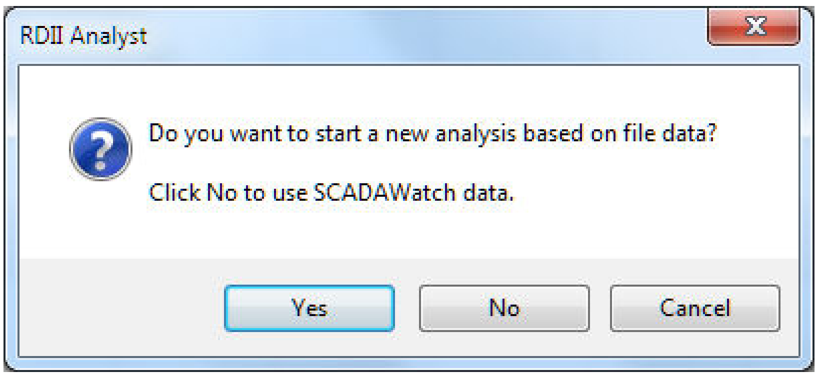


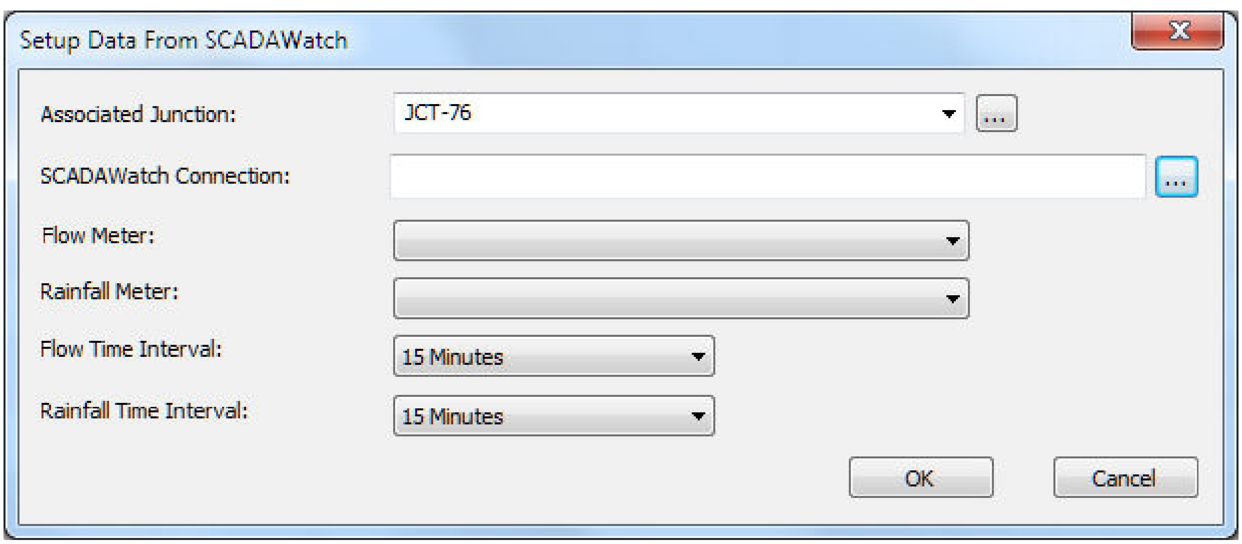
New Analysis Dialog Box

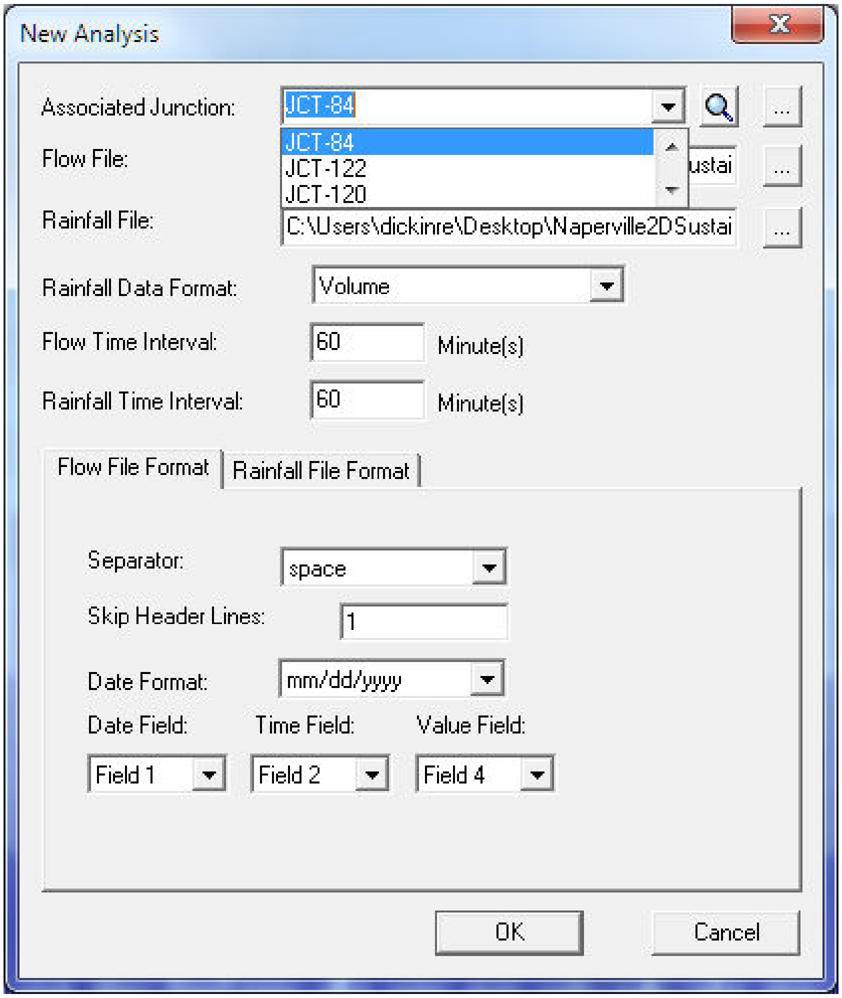
RDII Analyst reads flow monitoring data and the corresponding rainfall data, and performs a series of analyses to decompose the flow monitoring data into DWF, groundwater flow (GWI) and RDII flow components. Various flow data and rainfall data formats are accepted. The data files and the data formats are specified using the New Analysis dialog editor shown and described below. The dialog can be launched from the Main Menu with

File> New> or by clicking the **New Tool Button**  from the tools.

There is an option to either import data from SCADAWATCH or load from data file







Associated Junction: Enter the junction ID or use the Browse button to locate the flow monitoring site on the Map View.

Search ( **)**: An input profile is saved after a successful import. Click this button to search for the profile for the Associated Junction.

Flow File: Enter the path or use the Browse button to locate the flow data file.

Rainfall File: Enter the path or use the Browse button to locate the rainfall data file.

Rainfall Data Format: Specify if the rainfall data represents rainfall intensity, rainfall volume over the rainfall time interval or, a cumulative rainfall over time.

Flow Time Interval: Select the time interval at which the flow data is measured.

Rainfall Time Interval: Select the time interval at which the rainfall data is measured.

OK: Select OK after all fields are entered to start the data import process.

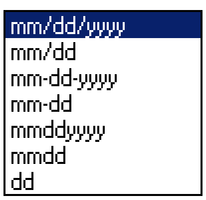
Cancel: Select Cancel to abandon all changes and return to the RDII Analyst.

<u>Flow File Format Tab</u>

Separator: Select the field separator used in the data file. This determines how the data columns are separated from one another in a row. Comma, tab, space, colon and semicolon are supported.

Skip Header Lines: Number of header lines to skip when reading the data file.

Date Format: Select the date format used for the flow monitoring data. The following formats are supported:

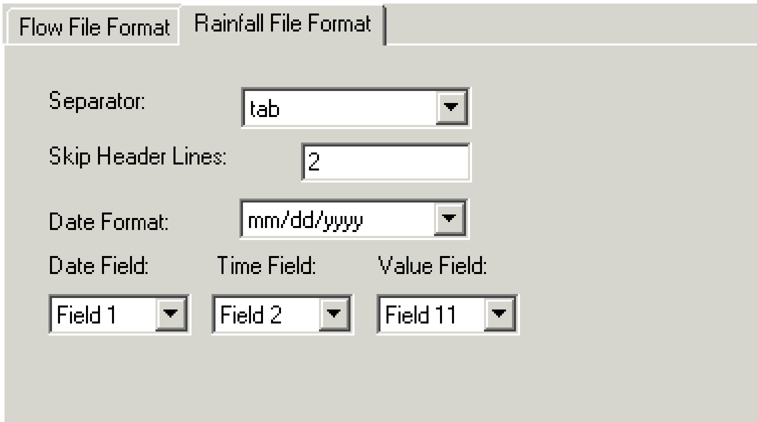


Date Field: Select data column (field) that contains the date field.

Time Field: Select data column that contains the time field.

Value Field: Select the data column that contains the flow values.

<u>Rainfall File Format Tab:</u>



Separator: Select the field separator used in the data file. This determines how the data columns are separated from one another in a row. Comma, tab, space, colon and semicolon are supported.

Skip Header Lines: Number of header lines to skip when reading the data file.

Date Format: Select the date format used for the rainfall monitoring data. The following formats are supported:

Date Field: Select data column (field) that contains the date field.

Time Field: Select data column that contains the time field.

Value Field: Select the data column that contains the rainfall values.

Once the above information is specified for the flow monitoring data and rainfall data, then click the OK button. The monitoring data and the rainfall data will be processed and presented both graphically and in report form in the Flow Data Tab and the Rainfall Data Tab.

See Also

Flow Data Tab

Rainfall Data Tab

[Main Menu]

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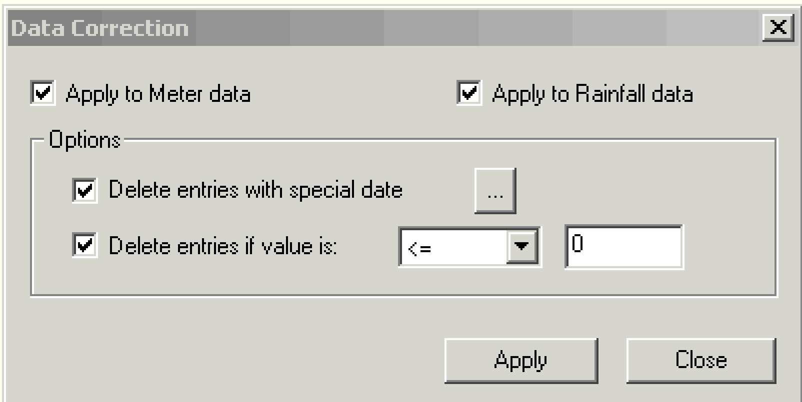
Data Correction

The flow data and the rainfall data read into RDII Analyst may be corrected using the Data Correction feature available from the Data Management menu.

In addition to the data correction options described below, the user can manually edit/delete data rows as needed and save the changes. From the Main Menu select Analysis> Data Correction>



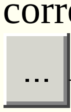
- Apply to Meter Data:

  Check this option to apply data correction to flow data.

- Apply to Rainfall Data:

  Check this option to apply the data correction to rainfall data.

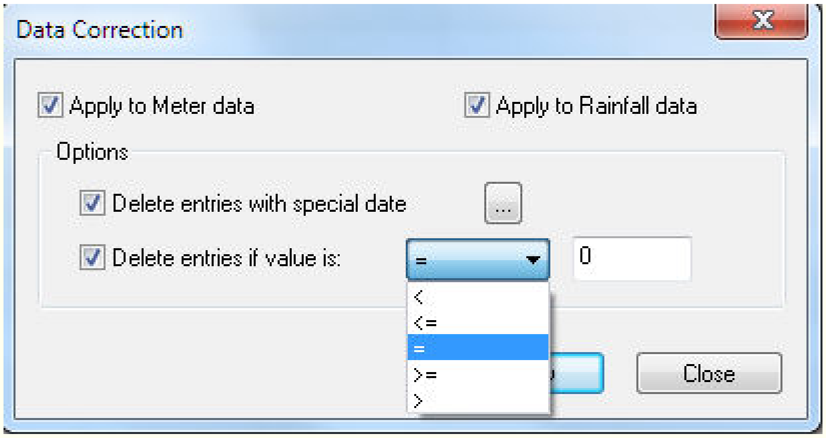
- Options
- Delete

  entries with special date: If checked, this option deletes data corresponding to the days defined as Special Days. Use the Browse 

button to launch the Special Days Editor.

- Delete entries if value is:

  This option is designed to delete rows with values that are used as a code to describe missing or null data. Select one of the operators below and enter a value. i.e. Delete entries if value is = 9999.



See Also

[Special Days Editor]

[Main Menu]

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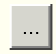
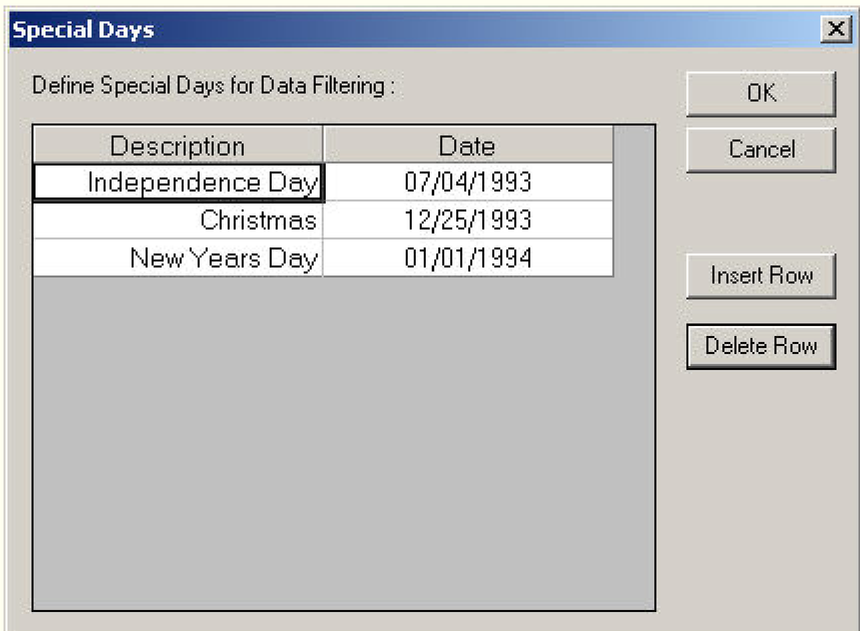
Special Days Editor

Special dates such as holidays, which do not represent typical DWF days, may also be removed from the data. Use the Special Days Editor to enter a list of non-typical days to be ignored. The Special Days Editor can be accessed from the RDII Analyst Main Menu with the Data Management> Special Days> command or directly from the Browse 

button of the Data Correction function.



- Description: Enter the

  description for the special day.
- Date: Enter the date

  of the non-typical day.
- Insert Row: Inserts a new row.
- Delete Row: Deletes the current row.
- OK: Save data and close

  the Special Days Editor.

- Cancel: Abandon all

  changes and close the Special Days Editor.

See Also

[Data Correction]

[Main Menu]

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Wet Weather Flow Components

There are three

major components of wet-weather wastewater flow into a sanitary system: 1) base wastewater flow, 2) groundwater infiltration and 3) RDII flow. The figure depicts the three major components of wastewater flow.

Base wastewater flow (BWF), often called base sanitary flow, is the residential, commercial, institutional and industrial flow discharged to a sanitary sewer system for collection and treatment.

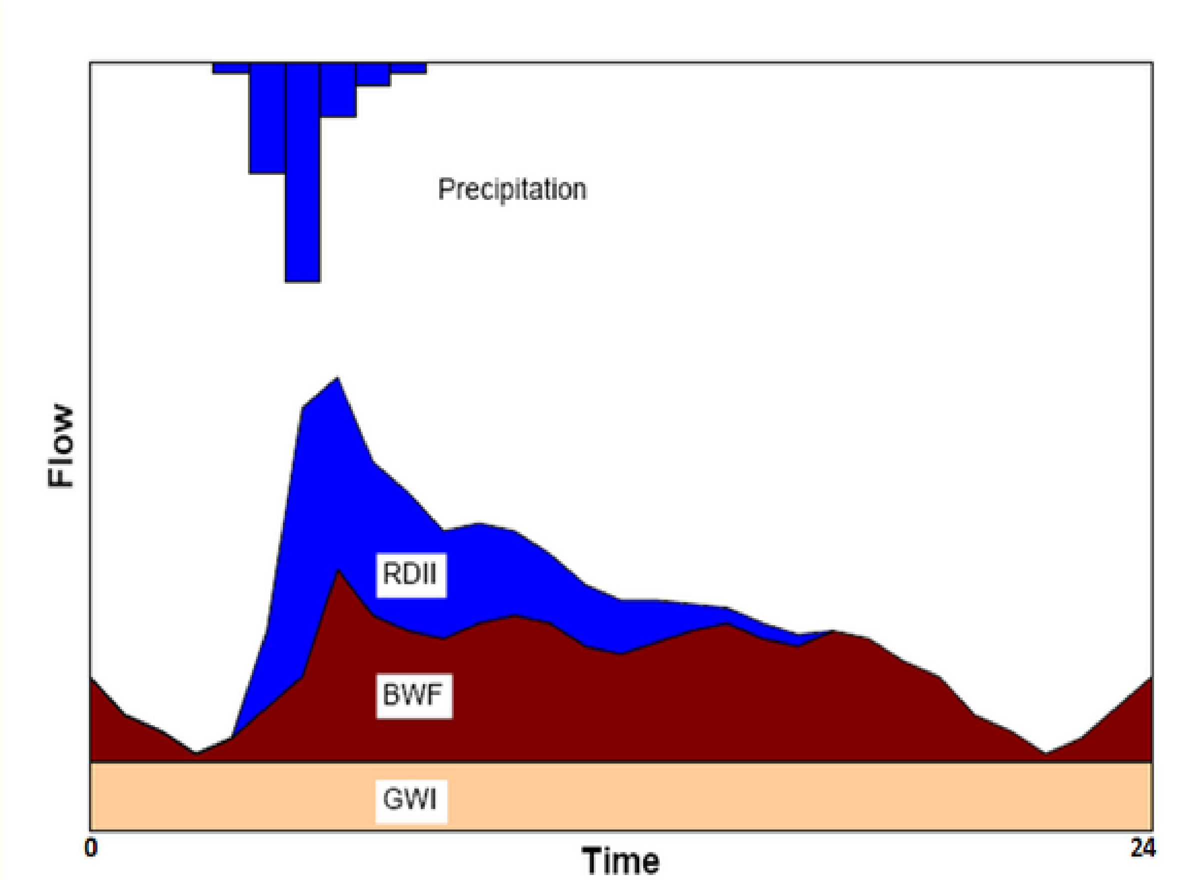
BWF normally varies with water use patterns within a service area throughout a 24-hour period - with higher levels during the morning period and lower during the night. In most cases, the average daily BWF is more or less constant during a given day but varies monthly and seasonally. BWF often represents a significant portion of the flows treated at wastewater treatment facilities.

Groundwater infiltration (GWI) represents groundwater that enters the collection system through leaking pipes, pipe joints and manhole walls. GWI varies throughout the year, often trending higher in late winter and spring as groundwater levels and soil moisture levels rise. It usually subsides in late summer or after extended dry periods.

Together, GWI and BWF comprise the dry-weather flow (DWF) that occurs in the sanitary sewer system. Because determining GWI and BWF components of DWF is not an exact science, various assumptions related to the water consumption return rates and wastewater composition during early morning hours are typically used to estimate these flows components.

Rainfall Derived Infiltration and Inflow (RDII) flow refers

to the flow pattern is varied from the DWF because of the influence from the rainfall. It starts at the same time the rainfall begins, and it ends when the flow pattern returns back to the pre-rainfall level.



Source: SSOAP Toolbox Help File

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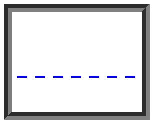

Comparison between RDII Analysis using RTK parameters and RTK with IA Parameters

Comparison between RDII Analysis using RTK parameters and RTK with IA parameters

	RDII Analysis using RTK Parameters[2]	RDII Analysis using RTK with IA Parameters[3]
Examples of Typical Usage[1]	· Quantification of wastewater flow components (BWF, GWI, and RDII) · Prioritization of sewershed for field investigation to support sewer conditions assessment, based on RDII. · Support Capacity Assessment / Assurance	· Quantification of wastewater flow components (BWF, GWI, and RDII) · Prioritization of sewershed for field investigation to support sewer conditions assessment, based on RDII. · Support Capacity Assessment / Assurance
Advantages	· Support a wide-range of RDII quantification needs using	· Can explicitly quantify antecedent moisture conditions along with RDII quantification and supports advanced

	both short and long-term data. · Offers easier and effective means to design a focused sewer system condition assessment program. The total R-value and its components help to efficiently prioritize where to inspect and to assess the performance of rehabilitation activities.	level long-term continuous simulations. · Estimates effective R-value after accounting for IA in response to rainfall event which helps in higher level understanding of a sewer system RDII behavior.
Disadvantages	· Require caution when selecting an appropriate R-value with consideration to desired antecedent moisture conditions to be used in the capacity	· Applicable when long-term (> 1 year) rainfall and flow data is available to establish the monthly, seasonal and yearly variation in IA and R-values. Limited insights and advantage when analyzing short-term data.

	assessment / assurance efforts. · Cannot explicitly quantify antecedent moisture conditions to support advanced level continuous simulations.	• More continuous modeling focused approach. More parameters (up to 18) for RDII hydrograph fitting and the demands an experienced/trained user to fully benefit the program capabilities. • Additional data analysis does not provide increased value for condition assessment programs.

1 - These are examples of typical usages but are not a fixed requirement, nor a comprehensive list. Ultimately the user must decide which method is appropriate to the data they have available and the objectives of their analysis.

2 - RTK is an analysis using up to three unit hydrographs each with R, T, and K parameters.

3 - RTK w/ IA is an analysis using up to three unit hydrographs each with R, T, K, and each with the three parameters related to initial abstraction (IA), Max. Depth, Recovery Rate, Starting Depth.

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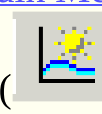
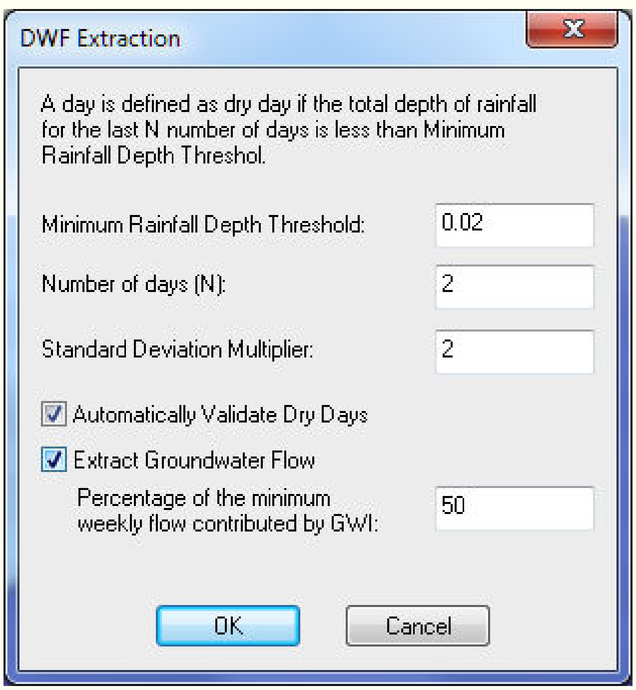
DWF Extraction

The first step towards determining the DWF component of the flow data is to identify dry days and wet days. The objective is to extract dry days (i.e., days not affected by precipitation) from the flow data, and to perform DWF analysis on these dry day flows. A day is defined as a dry day if the total depth of rainfall for the last user defined number of days is less than a given threshold. The presumption is that if there is no rain for extended number of days, the measured flow data represents the DWF component and the GWI component, but not the RDII flow component. The DWF component identified using this criterion can be further analyzed and verified manually or guided by statistical tools available from RDII Analyst.

The DWF Extraction inputs are specified on the DWF Extraction dialog editor shown below. The editor can be launched from the Main Menu with Analysis> DWF Extraction> or from DWF Extraction Tool () Button.



- Minimum Rainfall Depth

  Threshold: This refers to the cumulative volume of rain that should not be achieved or exceeded over the last N Number of Days for a day to be defined as a dry day, otherwise the day is defined as a wet day.

- Number of Days (N):

  Number of consecutive days to be defined as a dry day.

- Standard Deviation Multiplier

  - Days categorized as dry days based on Minimum Rainfall Depth Threshold and Number of Days (N) criteria may be further verified guided by statistical parameters such as the mean and the standard deviation of flow values for the identified dry days. If flow value for dry day X is less than mean minus the standard deviation multiplier* the standard deviation or higher than mean + standard deviation multiplier*

  the standard deviation, then that flow value may be an outlier (i.e., it may not be a representative dry day value). If that happens, the user has the option to discard the day from the dry day list.

- Automatically Validate

  Dry Days: If the Automatically Validate Dry Days option is checked, then the program automatically discards dry days that meet the criterion. Otherwise, the user can manually delete dry days that are outliers.

- Once determined, the dry days flows are presented both in report form and in graph form for weekend and for weekdays. See Dry Day Flow Tab

- Determining the Groundwater

  Flow

- In areas where groundwater table is high (i.e., close to ground surface), groundwater flow may enter sewer systems through pipe cracks, through joints or through manhole covers. Groundwater flow to sewer systems may not show significant variability with time. In RDII Analyst, groundwater component is assumed as the minimum weekly flow extracted from the dry days. The minimum weekly dry day flows can be adjusted by a user-defined multiplier shown below.

- Extract Groundwater Flow:

If the Extract Groundwater Flow is checked the fraction of flow attributed to groundwater will be calculated.

- Fraction of the minimum

  weekly flow contributed by GWI: This multiplier adjusts the weekly minimum flows extracted from the dry day flows. The product of this multiplier and the minimum weekly flows would be reported as groundwater flow contribution. See Ground Water Tab

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See Also

Dry Day Flow Tab,

Ground Water Tab

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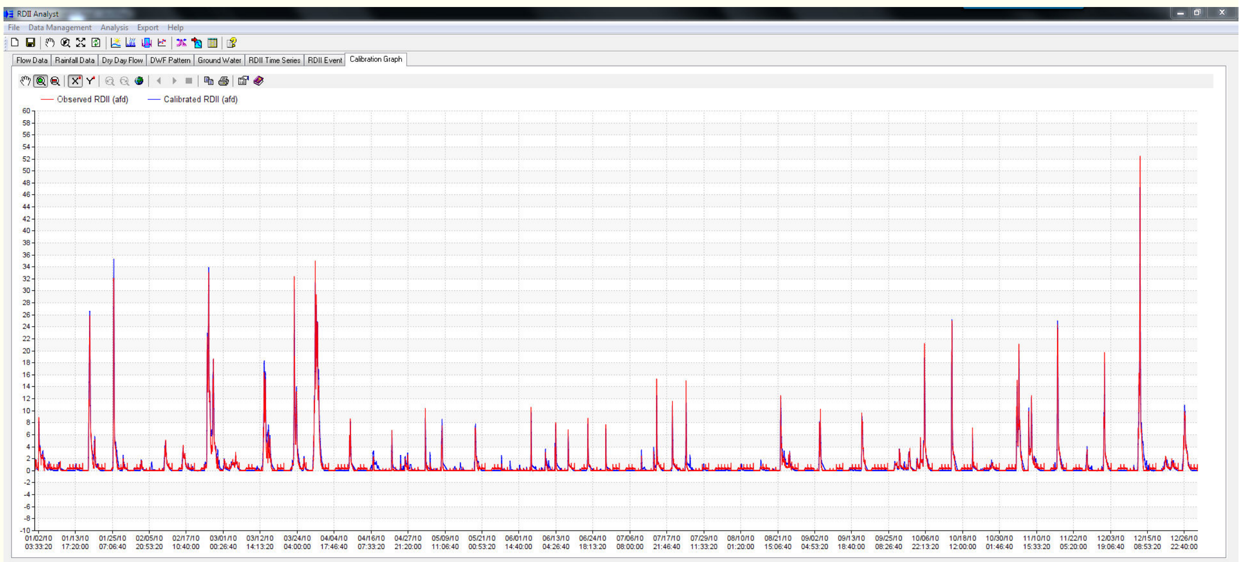
RDII Time Series

RDII flow is the difference between the corrected monitoring flow data, and the sum of average hourly DWF pattern and the groundwater flow time series. Once the hourly DWF pattern and the groundwater flow components are identified, the sum of the two components would be subtracted from the corrected flow data to determine the RDII flow component. Determination of RDII time series can be launched using the  Tool Button or from the Main Menu using Analysis> RDII Analysis> Compute

RDII Time Series>.



See Also

Analysis Menu

RDII Time Series Tab

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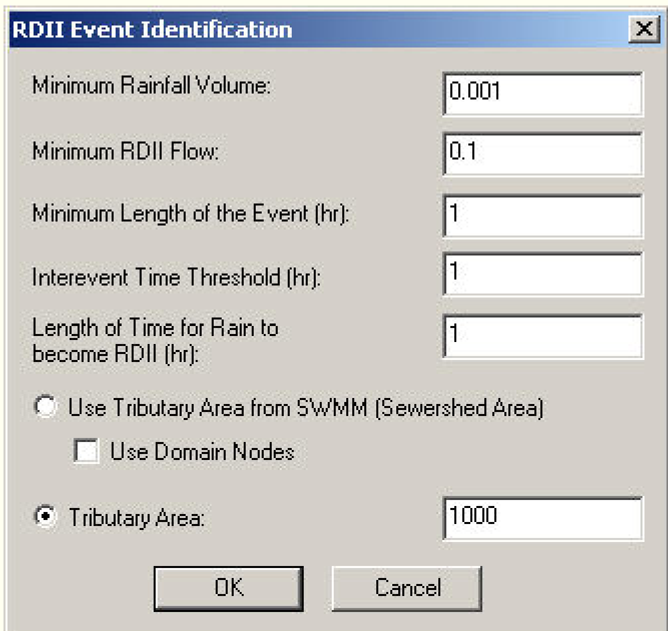
RDII Event Identification

RDII Analyst can further analyze the RDII time series to identify RDII events. Breaking RDII time series into separate events can assist to better understand the RDII process and to calibrate the model. Event definition depends on the values assigned to the inputs given in the RDII Event Identification dialog box shown below. The RDII Event Identification settings are available from the Main Menu at Analysis> RDII Analysis> Event Identification>.



- Minimum Rainfall Volume:

  represents the minimum rainfall depth that needs to be collected from "continuous" rain to initiate an event. By continuous rain, it means that time interval between successive rains should not exceed the inter-event time threshold defined by the user.

- Minimum RDII Flow:

  represents the minimum RDII flow that should be generated as the result of the rainfall collected over the duration to accept the occurrence as an event.

- Minimum Length of the

Event (hr): refers to the minimum length of time that the RDII flow should exceed the minimum RDII flow for the occurrence to be accepted as an event.

- Inter-event Time Threshold

  (hr): refers to the length of time needed to separate two successive events. If two rainfall occurrences are separated by duration shorter than the Inter-event Time Threshold, then the two rainfall occurrences are considered as one occurrence.

- Length of Time for Rain to Become RDII (hr): is the time needed for the rain event to become infiltration and inflow.

- Use Tributary Area from

  SWMM: The user can directly specify area of the tributary sewersheds.

  If selected the RDII Analyst can use the sewershed area defined in Innovyze RDII Analyst

  ’s RTK Hydrograph page.

- Use Domain Nodes:

  If the Use Domain Node option is checked, Sewershed area of the nodes included in the domain will be considered. Nodes in the domain will not contribute sewershed area.

- Tributary Area:

  This input is used to compute RDII flow depth based on RDII flow volume determined for each event.

- When the Event identification process is completed the Event Graph is generated. See: Event Graph

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See Also

Event Graph

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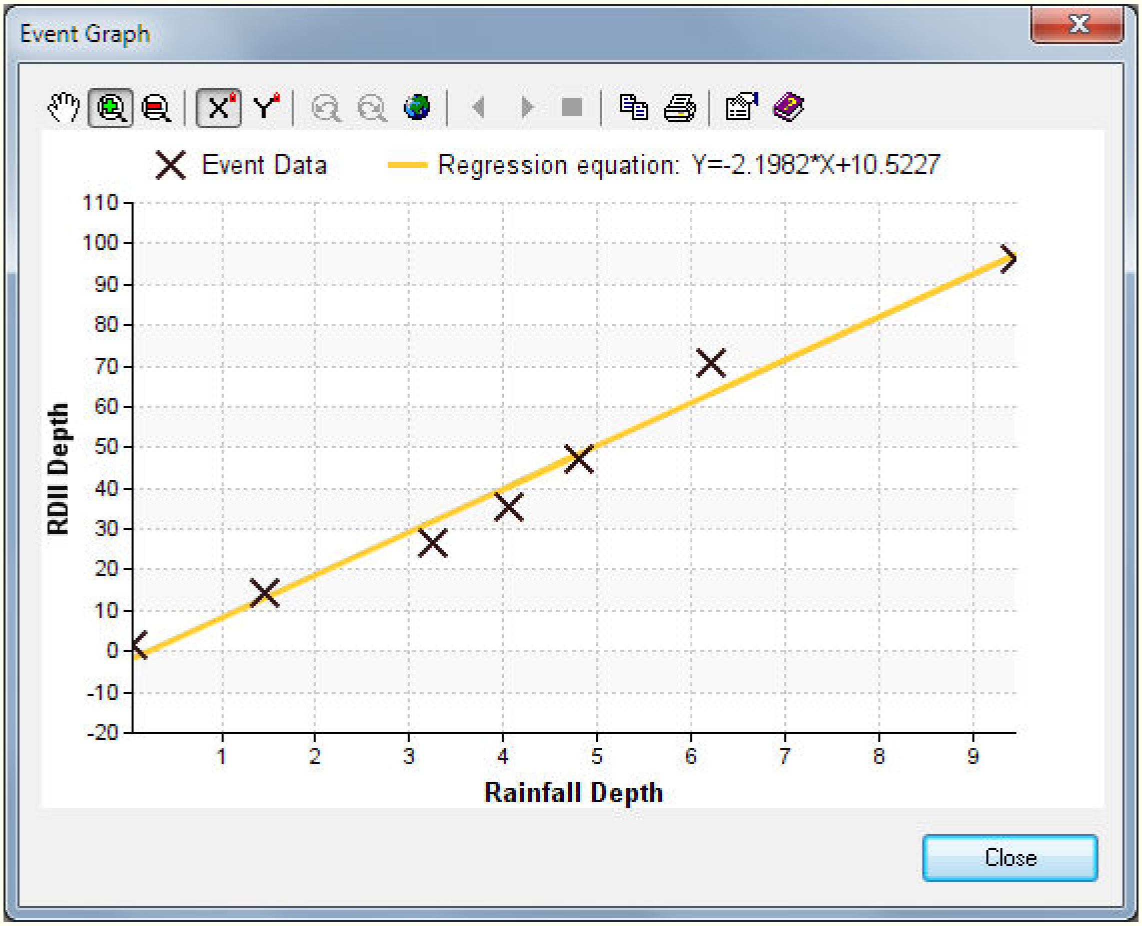
Event Graph

The RDII Event Identification process Generates the Event Graph.

A linear regression equation is developed between the RDII depth and rainfall depth identified for each event. Slope of the regression equation represents the fraction of rainfall depth that enters the sewer system in the form of RDII (i.e., a representative R for all events). The Regression analysis result is given graphically in the Event Graph shown below.



See Also

RDII Event Identification

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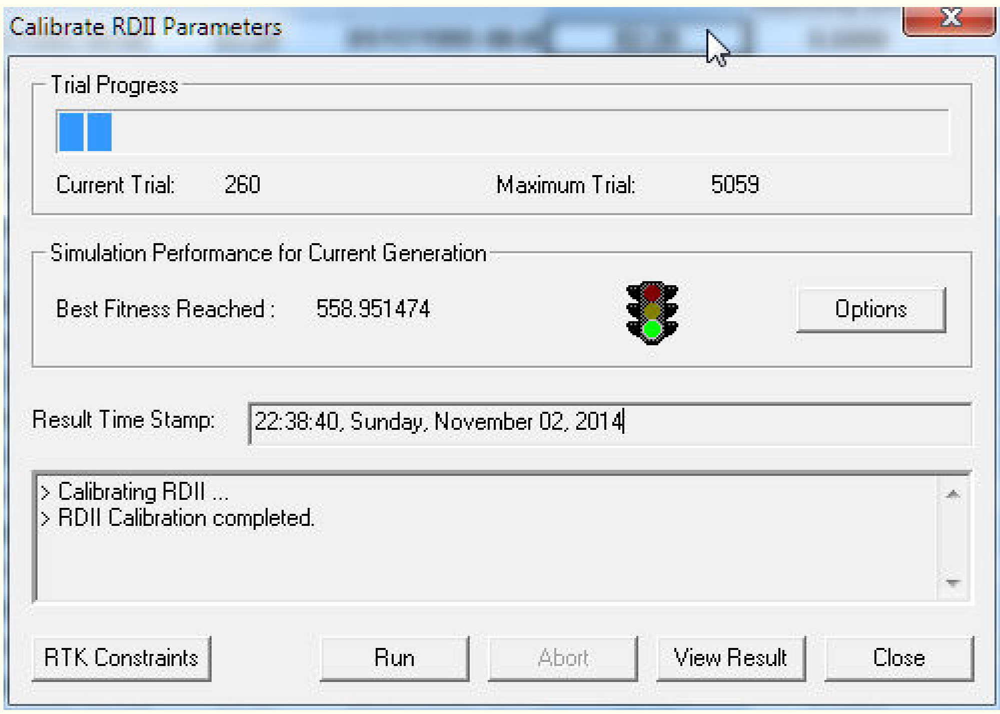
Calibrate RDII Parameters

The calibration tool systematically searches for the best set of parameters that matches the RDII flow simulated by Innovyze RDII Analyst

with RDII time series determined by the decomposition process. The parameter values will be searched within the minimum and the maximum ranges assigned by the RDII Calibration Parameters

Click on some areas of the image below for additional information:



- Options: Sets

  the options for the genetic algorithm. See: GA Options
- RTK Constraints: Sets the calibration parameters. See: RDII Calibration Parameters
- Run: Starts the

  calibration process.
- Abort: Stops the

simulation.
- View Results:

  View the Calibration Report.

- Close: Close the

  Calibrate RDII Parameters window.

See Also

RDII Calibration Parameters,

GA Options,

RDII Calibration Parameters,

Calibration Report

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RDII Calibration Parameters

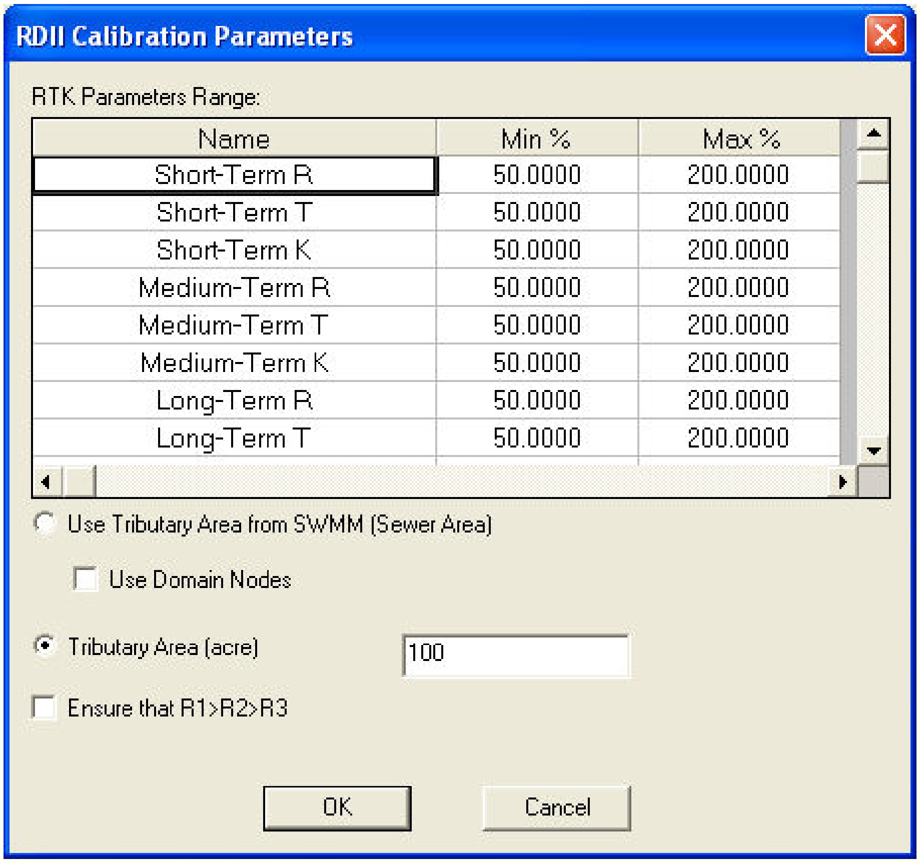
One of the objectives of decomposing a flow monitoring data into the dry weather flow and the wet weather flow components is to improve accuracy of modeling the wet-weather flow component. In Innovyze RDII Analyst , RDII flow is modeled using the RTK method as previously described. The RTK method requires definition of up to 12 parameters. Proper choice of these parameters is crucial for accurate modeling of the RDII flow. Traditionally, RDII UH parameters are assigned using a tedious and inexact trial-and-error process in which the parameters are manually adjusted in an iterative fashion to closely match wet-weather flow data with the RDII flow generated by the simulation model using the assumed RTK parameters. Since there are a vast number of possible combinations of RTK values, evaluating all options this way may not be manageable, and even knowledgeable modelers often fail to obtain good results. RDII Analyst uses Genetic Algorithms (GA) optimization to automatically determine the UH parameters that best match the RDII time series generated by the RDII Analyst with the RDII flow estimated using Innovyze RDII Analyst

.

The RDII calibration tool is launched from the Main Menu

using Analysis -> Calibrate RDII Parameters or using the  Tool Button.

Minimum and the maximum range of the parameters should be defined using the RDII Calibration Parameters editor.



Brief description of the features of this tool is given below.

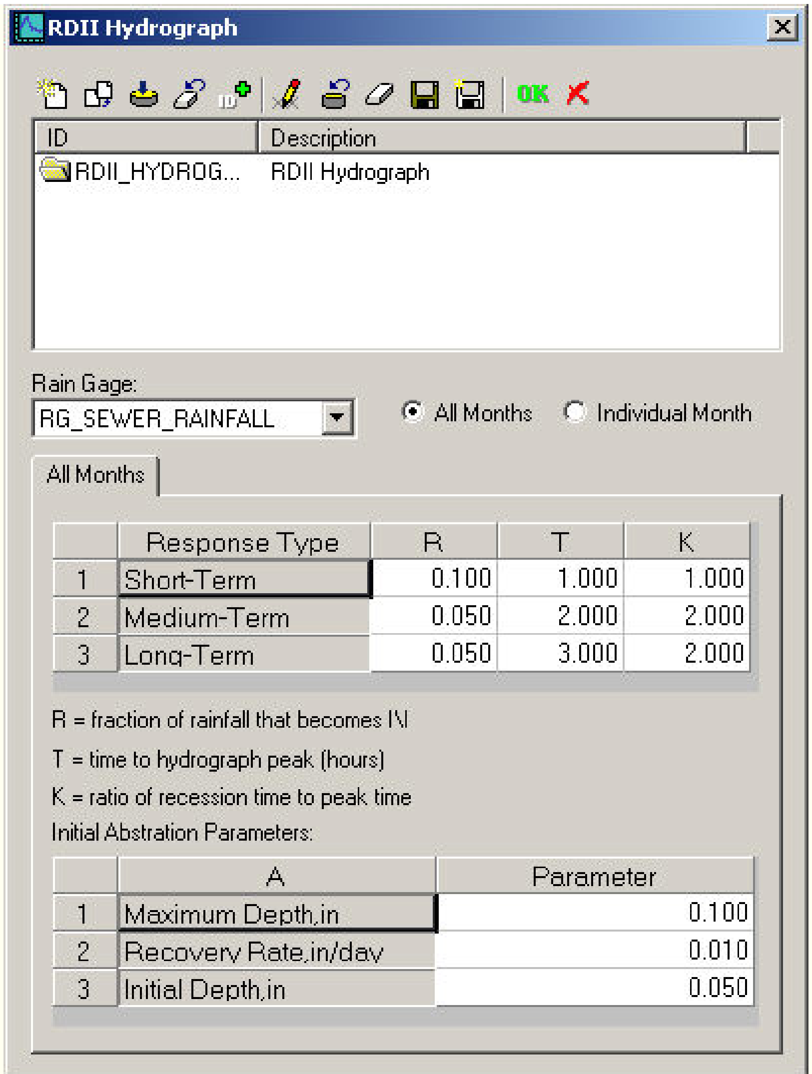
Name	Description
Name	Parameter name
Min%	Minimum percentage
Max%	Maximum percentage
Use Tributary Area from SWMM	The user can directly specify area of the tributary sewersheds. If selected the RDII Analyst can use the sewershed area defined in Innovyze RDII Analyst's RTK Hydrograph page.
Use Domain Nodes	If the Use Domain Node option is checked, sewershed area of the nodes included in the domain will be considered. Nodes in the domain will not contribute sewershed area.

Tributary Area	This input is used to compute RDII flow depth based on RDII flow volume determined for each event.
Ensure that R1>R2>R3	If selected, this option ensures that the RDII flow contributed by the first triangle (fast flow contribution) would be higher than contribution of the second triangle (intermediate flow), and contribution of the second triangle would be higher than that of the third triangle (slow flow).

The calibration tool systematically searches for the best set of parameters that matches the RDII flow simulated by Innovyze RDII Analyst with RDII time series determined by the decomposition process. The parameter values would be searched within the minimum and the maximum ranges assigned by the user on dialog editor shown above. The model would adjust the nominal parameter values assigned by the user on Innovyze RDII Analyst RDII hydrograph dialog editor (see below) by a randomly selected multiplier within the range assigned for the parameter and chooses the optimal set of adjustments. The Tributary Area may be taken from the sewershed area defined in Innovyze RDII Analyst

’s Hydrograph page, or the user can directly specify area of the tributary sewersheds. In addition, the user has the option to use sewershed area of the nodes defined in a domain. If the Use Domain Node option is checked, sewershed area of the nodes included in the domain will be considered.

Nodes in the domain will not contribute sewershed area. Once the parameters are assigned, hitting the OK button would initiate the calibration dialog box. See: Calibrate RDII Parameters

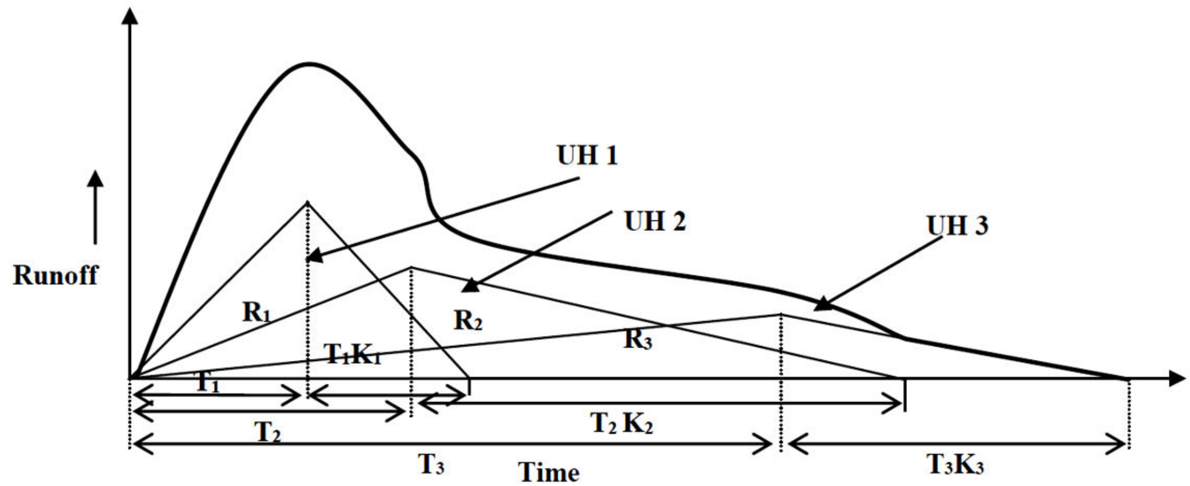


RDII Hydrograph Editor

from InfoSWMM

How the R (rainfall

to flow fraction) and the T and K parameters (T*K or the Base of the Unit Hydrograph) are related visually. There a three R, three T or time parameters and three K parameters.



See Also

[Calibrate RDII Parameters]

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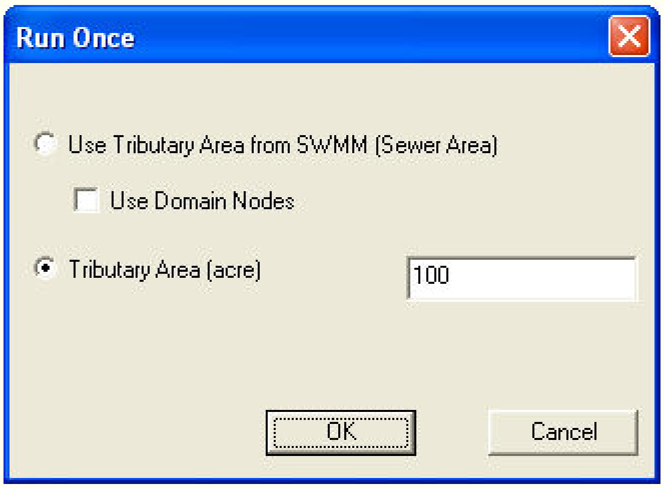
RDII Calibrate With Current Parameters

If you wish to check the calibration of RTK parameters that you have estimated using local knowledge and judgement, you can do this by initiating the Run Once (with current RTK parameters) button (). The results can be checked by viewing the Calibration Graph Tab

The following dialog box will be initiated:

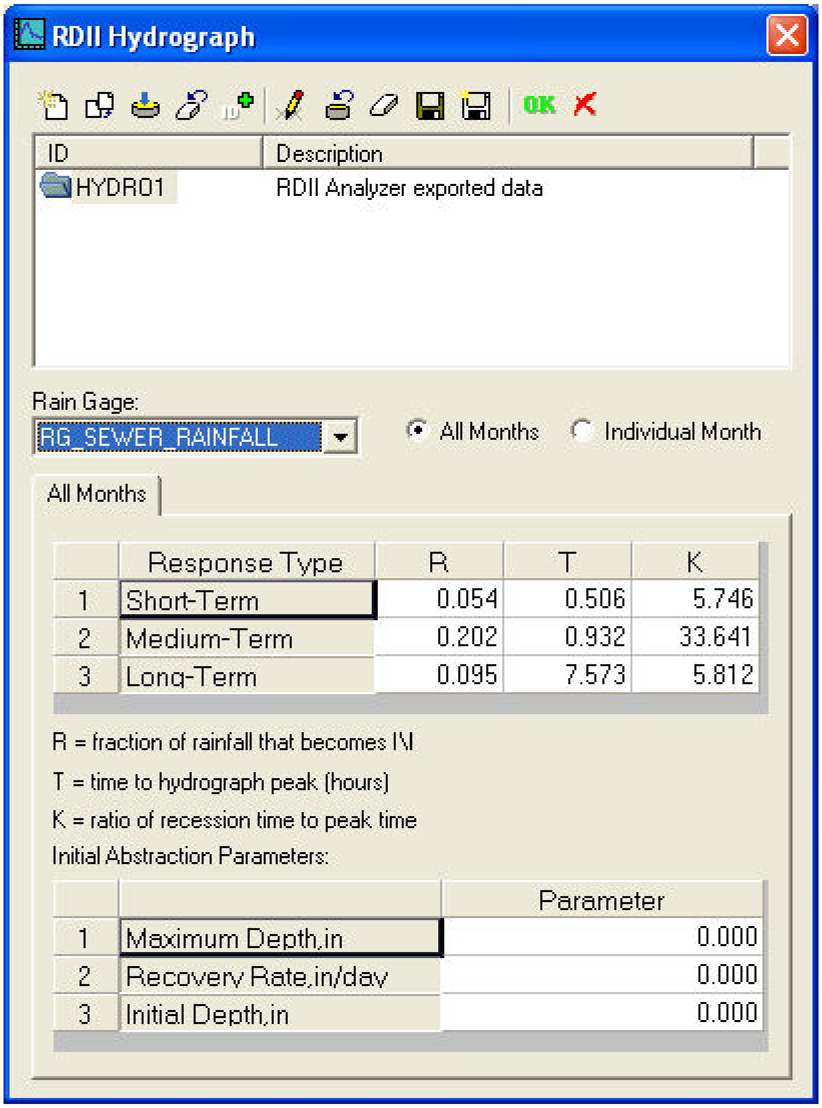


Brief description of the features of this tool is given below.

Name	Description
Use Tributary Area from SWMM	The user can directly specify area of the tributary sewersheds. If selected the RDII Analyst can use the sewershed area defined in Innovyze RDII Analyst's RTK Hydrograph page.
Use Domain Nodes	If the Use Domain Node option is checked, sewershed area of the nodes included in the domain will be considered. Nodes in the domain will not contribute sewershed area.

Tributary Area	This input is used to compute RDII flow depth based on RDII flow volume determined for each event.

The RTK parameters that will be checked for calibration will be those for the selected RDII Hydrograph (select Hydrograph from the Analysis menu):



See Also

[Calibrate RDII Parameters]

RDII Calibration Parameters

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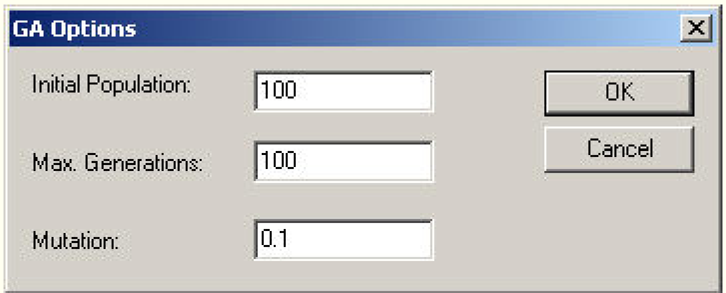
GA Options

Genetic Algorithms parameters may be defined using the options page initiated by clicking the Options button on the Calibrate RDII Parameters dialog box.



- Initial Population:

  Represents the number of initial solution candidates considered by the GAs calibrator. Each solution candidate contains a value with in the assigned range for each RTK parameters. The higher the Initial Population the better the calibration results would be. However, the calibration process can take more time as the number of population increases.

- Max. Generation: Represents

  the maximum number of iterations required to complete the calibration process. One generation represents running the model for initial population number of times, and each simulation represents different solution candidates. The higher the maximum generation, the better the chance of improving the calibration. Again, the improvement comes at the cost of more calibration run time. The calibration process can stop before reaching the maximum generation if there is no improvement in results from generation to generation.

- Mutation Rate: Represents

  the percentage of solution candidates whose one or more parameter values needs to be randomly altered to inject new and potentially better solution candidates into the search process during each generation.

The value must be with in zero and one, and typical value is 0.1.

See Also

Calibrate RDII Parameters

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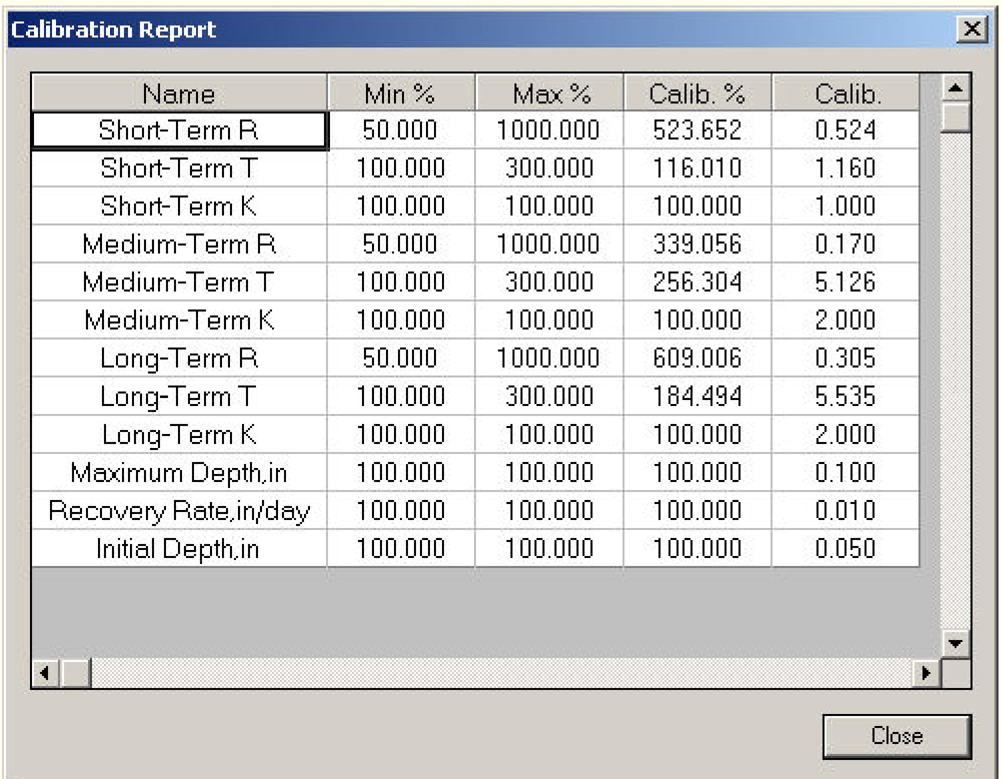
Calibration Report

Upon completing the calibration run (see: Calibrate RDII Parameters), the best RTK parameter values would be reported as shown below. The percentage adjustment and then actual parameter values suggested are reported in the last two columns. In addition, graphical comparison of the RDII flow generated by the calibrated parameters and the RDII Time Series generated by the decomposition process would be provided to visually analyze the calibration results. The RDII Event Analysis Results is shown on the RDII Event Tab.



Name	Min %	Max %	Calib. %	Calib.
Short-Term R	50.000	1000.000	523.652	0.524
Short-Term T	100.000	300.000	116.010	1.160
Short-Term K	100.000	100.000	100.000	1.000
Medium-Term R	50.000	1000.000	339.056	0.170
Medium-Term T	100.000	300.000	256.304	5.126
Medium-Term K	100.000	100.000	100.000	2.000
Long-Term R	50.000	1000.000	609.006	0.305
Long-Term T	100.000	300.000	184.494	5.535
Long-Term K	100.000	100.000	100.000	2.000
Maximum Depth,in	100.000	100.000	100.000	0.100
Recovery Rate,in/day	100.000	100.000	100.000	0.010
Initial Depth,in	100.000	100.000	100.000	0.050

See Also

Calibrate RDII Parameters

RDII

Time Series

RDII Event Analysis Results

RDII Event Tab

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RDII Event Analysis Results

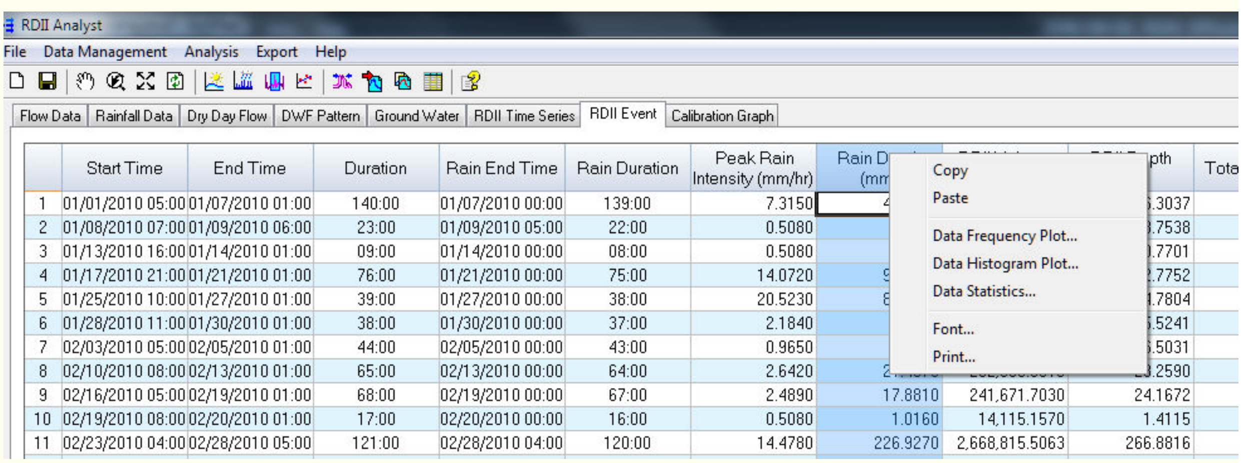
The identified RDII events are summarized in the table shown below under the RDII Event Tab.

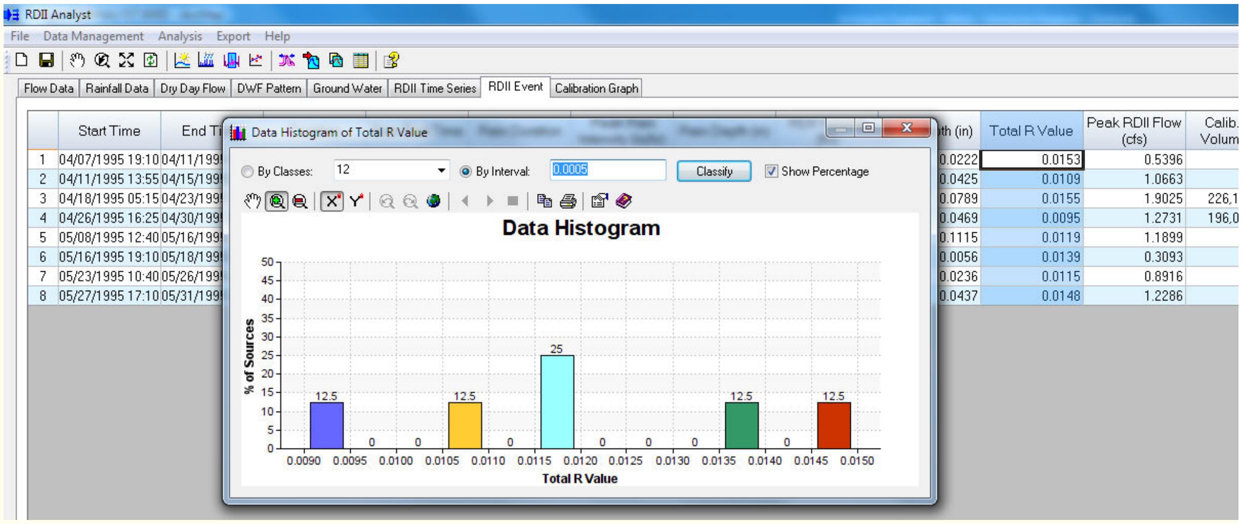
The report may be expanded as shown below or use the scroll bars to navigate the report.

New to InfoSWMM

14.5 Update #1 is the ability to graph frequency and statistics for the event table. The new commands are:

- Copy
- Paste
- Data Frequency Plot
- Data Histogram Plot
- Data Statistics
- Font and
- Print





	Start Time	End Time	Duration	Rain End Time	Rain Duration	Peak Rain	Rain Depth	RDII Volume	RDII Depth	Total R Value	Peak RDII Flow
0	01/01/1995 02:35	01/01/1995 05:00	02:25	01/01/1995 04:00	01:25	0.0100	0.1000	849.13	0.0002	0.0023	0.1238
1	01/13/1995 23:10	01/17/1995 11:00	83:50	01/17/1995 10:00	82:50	0.0200	2.7500	148412.91	0.0409	0.0149	1.3215
2	01/19/1995 20:15	01/19/1995 22:00	01:45	01/19/1995 21:00	00:45	0.0100	0.0500	790.65	0.0002	0.0044	0.1603
3	03/20/1995 02:05	03/20/1995 10:00	07:55	03/20/1995 09:00	06:55	0.0300	1.3500	8378.89	0.0023	0.0017	0.4854
4	03/20/1995 19:35	03/21/1995 13:00	17:25	03/21/1995 12:00	16:25	0.0100	0.0500	12634.86	0.0035	0.0696	0.3000
5	03/27/1995 17:50	04/04/1995 13:00	187:10	04/04/1995 12:00	186:10	0.0300	1.1500	417236.19	0.1149	0.0999	1.3524
6	04/07/1995 20:15	04/08/1995 14:00	17:45	04/08/1995 06:00	09:45	0.0200	0.8500	31157.49	0.0086	0.0101	0.6884
7	04/08/1995 22:50	04/10/1995 13:00	38:10	04/10/1995 12:00	37:10	0.0100	0.5000	28495.48	0.0078	0.0157	0.3429
8	04/11/1995 14:10	05/22/1995 14:00	983:50	05/22/1995 13:00	982:50	0.0700	22.9500	2191958.06	0.6038	0.0263	3.9821
9	05/23/1995 04:45	05/26/1995 10:00	77:15	05/26/1995 09:00	76:15	0.0300	2.4500	95570.16	0.0263	0.0107	0.8044
10	05/27/1995 15:25	05/29/1995 07:00	39:35	05/29/1995 06:00	38:35	0.0500	3.7500	86050.18	0.0237	0.0063	1.7983
11	06/06/1995 15:45	06/07/1995 13:00	21:15	06/07/1995 12:00	20:15	0.1000	2.1000	17883.94	0.0049	0.0023	0.5694
12	06/07/1995 19:40	06/10/1995 09:00	61:20	06/10/1995 08:00	60:20	0.1300	2.0000	68999.32	0.0190	0.0095	1.1850
13	07/04/1995 11:15	07/04/1995 14:00	02:45	07/04/1995 13:00	01:45	0.1500	2.1500	4888.90	0.0013	0.0006	0.8184
14	07/15/1995 14:05	07/15/1995 16:00	01:55	07/15/1995 15:00	00:55	0.2100	2.3500	1878.64	0.0005	0.0002	0.4266
15	07/15/1995 21:30	07/16/1995 08:00	10:30	07/16/1995 07:00	09:30	0.0700	1.8000	9857.17	0.0027	0.0015	0.6908
16	07/24/1995 12:50	07/24/1995 14:00	01:10	07/24/1995 12:55	00:05	0.0100	0.1000	213.95	0.0001	0.0006	0.1274
17	08/03/1995 11:45	08/03/1995 13:00	01:15	08/03/1995 12:00	00:15	0.0300	0.2500	425.37	0.0001	0.0005	0.1414
18	08/04/1995 17:50	08/04/1995 20:00	02:10	08/04/1995 19:00	01:10	0.2000	3.3000	1992.74	0.0005	0.0002	0.3563
19	08/09/1995 08:20	08/10/1995 14:00	29:40	08/10/1995 13:00	28:40	0.2100	3.6000	31718.35	0.0087	0.0024	0.8768

See Also

RDII Event Tab

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Misgana K. Muleta and Paul F. Boulos RDII Paper

Click to view the PDF paper in the Help File Window

RDIIAnalystPaperASCE2008

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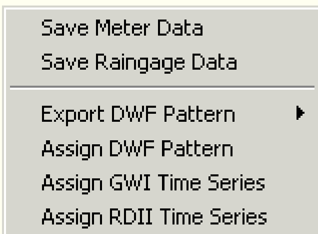
Exporting Analysis Results

Some of the RDII Analyst results can be exported to a text file or to InfoSWMM and can be used to model the collection system. The export tools are available from the Export Menu of the Main Menu.



- Save Meter Data:

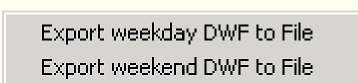
  This saves the corrected flow monitoring data to a text file for later use.

- Save Raingage Data:

  This function saves corrected rainfall data to a text file for later use.

- Export DWF Pattern:

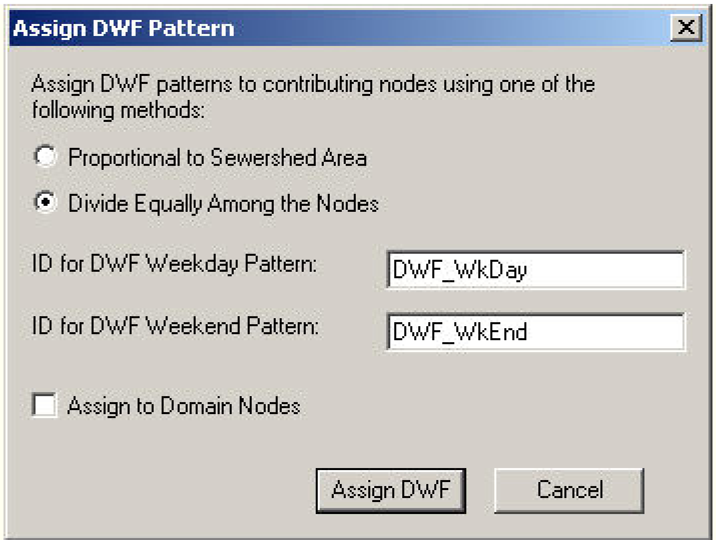
  This function exports hourly weekday or weekend DWF patterns to a text file.



- Assign

  DWF Pattern: This tool assigns the hourly DWF patterns developed for weekdays and weekends toInfoSWMM nodes that contribute flow to the monitoring site.

  The DWF pattern is allocated to the contributing nodes either proportional to sewershed area of each contributing node, or simply equally among all contributing nodes. The user must assign an ID to be used as the weekday and weekend pattern name. The assignment could be limited to nodes in a domain by checking the Assign to Domain Nodes option.

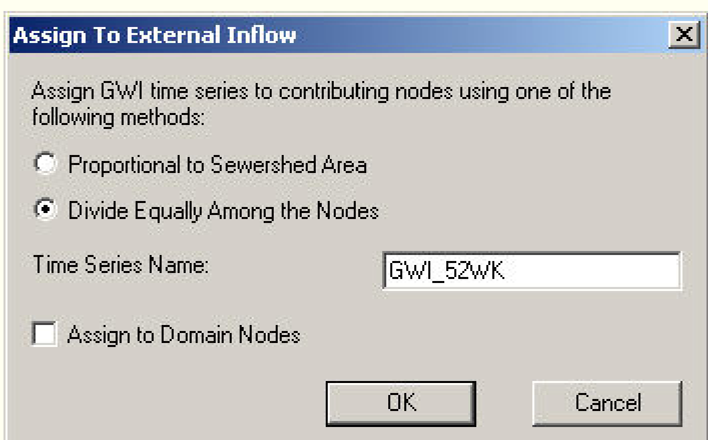


- Assign

  GWI Time Series: This function assigns the groundwater flow time series to InfoSWMM nodes that contribute flow to the monitoring site.

  The time series is assigned to the nodes as external inflow. The GWF

  time series is allocated to the contributing nodes either proportional to sewershed area of each contributing node, or simply equally among all contributing nodes. The user must provide a Time Series Pattern name. The assignment could be limited to nodes in a domain by checking the Assign to Domain Nodes option.

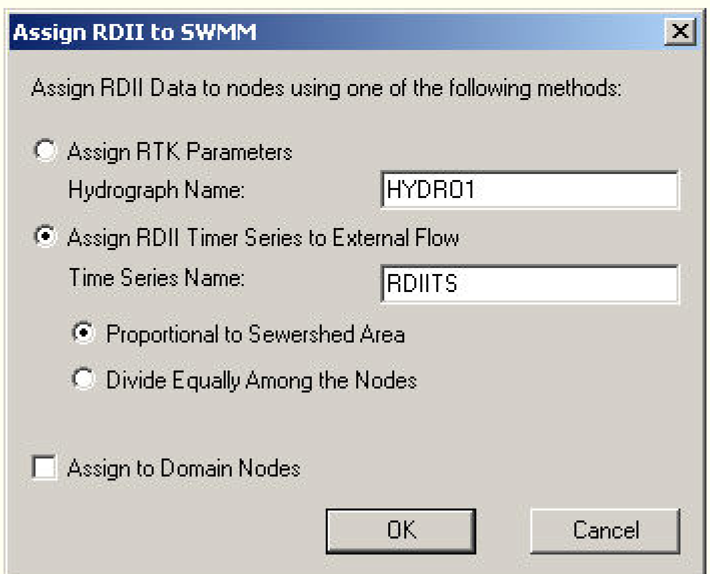


- Assign

  RDII: This function assigns either the RTK parameters determined by the calibration tool or the RDII time series determined by decomposing the flow monitoring data toInfoSWMM nodes that contribute flow to the monitoring site.

The RTK parameters could be exported to InfoSWMM and assigned to RDII hydrographs for each contributing node. The time series is assigned to the nodes as external inflow.

The RDII time series is allocated to the contributing nodes either proportional to sewershed area of each contributing node, or simply equally among all contributing nodes. The user must provide a name for the Hydrograph and/or the Time Series. The assignment could be limited to nodes in a domain by checking the Assign to Domain Nodes option. Please note that if both the GWF time series and the RDII time series are exported into InfoSWMM , only the time series exported last would be available for use. InfoSWMM takes only one external inflow time series at a time.



See Also

Main Menu

Export Menu

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Innovyze RDII

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Innovyze Contact Information

You can reach Innovyze® Inc. by phone, Monday through Friday.

Innovyze® technical support can be reached at:

Phone: (626) 568-6869 Fax:

(626) 568-6870

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Sales Email: Sales@Innovyze.com

Innovyze®Internet: http://www.Innovyze.com

Innovyze® Blog: http://blog.innovyze.com/

Innovyze® Forum: http://forums.innovyze.com/forum.php

Innovyze® Twitter: https://twitter.com/Innovyze

Innovyze® Linkedin Users: Innovyze Linkedin

Or write us at Innovyze® Inc.,

605 East Huntington Drive. Monrovia, CA 91016.

Software License Agreement

"The current version of Innovyze's Software License Agreement can be found at the following location: http://www.innovyze.com/licensing/"

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Home > Innovyze RDII Analyst Help File and User Guide > User Guide > Introduction by Innovyze CEO

Introduction

Excessive wet weather flow resulting from rainfall-derived inflow and infiltration (RDII) is a major source of sanitary sewer overflows (SSOs). SSOs pose serious problems to the public and the environment by causing back up into basements and sewer overflows to streets and rivers. Control of sewer overflows is, therefore, vital to reducing risks to public health and protecting the environment from water pollution.

Computer modeling of sewer collection systems plays an important role in determining sound and economical remedial solutions that reduce RDII, improve system integrity, reliability and performance, and avoid overflows.

Although sanitary sewer systems are generally designed to accommodate RDII flows, these flows often exceed the design allowances. RDII represents total wet weather flow that enters the collection system in the form of inflow and infiltration. Inflow is water that enters the sewer system directly via depressed manhole lids and frames, downspouts, sump pumps, foundation drains, area way drains and cross-connections with storm sewers. Inflow typically occurs shortly after a rainfall starts and recedes quickly once it stops and typically accounts for the major component of the RDII peak flow. Infiltration refers to runoff that infiltrates into the soil before entering a sanitary sewer system through damaged pipe sections, leaky joints or poor manhole connections. Infiltration processes typically extend beyond the end of rainfall and takes some time to recede to zero after the storm event. Both infiltration and inflow increase with age of the sanitary sewer infrastructure.

Mathematical drainage modeling can be used to analyze existing sewer collection systems, to identify potential problems, and to design optimal remedial solutions. For sanitary sewer systems in particular, the ability to determine RDII flows reliably is critical for developing SSO control plans. The processes that convert rainfall to RDII flow in sanitary sewer systems are very complicated. Various factors control RDII responses in addition to the rainfall and antecedent moisture conditions, including depth to groundwater, depth to bedrock, land slope, number and size of sewer system defects, type of storm drainage system, soil characteristics, and type of sewer backfill. Furthermore, RDII responses can vary greatly due to spatial rainfall distributions over a sewershed. Given this degree of complexity, if not supplemented by flow monitoring data, mathematical modeling of RDII inflows may not yield the degree of reliability desired to identify existing problems and to make sound and economical decisions to correct the identified problems.

The wastewater flow monitoring data collected at sewer collection systems consists of dry-weather flow components and RDII flow components. A crucial step towards successful modeling of sewer collection systems is the ability to decompose the flow monitoring data into the RDII flow and the dry-weather flow. The dry-weather flow component can be further classified into ground water flow and base flow. Groundwater flow represents the groundwater infiltration that enters the collection system through defective pipes, pipe joints, and leaking manhole walls irrespective of rainfall availability. Base wastewater flow represents sewage from residential, commercial, and industrial areas released to the sanitary sewer system. RDII is the rainfall-driven flow that makes its way to the collection system. The decomposition process can then be used to understand the sources of flow and the relative quantities of each flow components for the sewer system. Additionally, it determines if RDII and groundwater flow components are excessive to cause SSOs and other operational problems.

RDII Analyst performs comprehensive QA/QC of rainfall and flow data and decomposes the flow data into distinct dry-weather flow (DWF) and wet-weather flow (RDII) components using criteria such as rainfall threshold. The DWF component is further analyzed to construct a DWF pattern that can be used to simulate the system using InfoSWMM .

The DWF pattern is then assigned to the source nodes that contribute DWF

to the meter location in proportion to sewershed areas or based on other user-defined criteria. The RDII component is then analyzed to determine RDII events and to calibrate parameters of the RTK synthetic unit hydrograph so that the RDII flow simulated by the RTK method closely matches the RDII flow obtained by the decomposition process. The RTK unit hydrograph parameters are calibrated with genetic algorithm optimization. The calibrated RTK parameters and the DWF patterns are then passed to InfoSWMM to carry out detailed dynamic flow routing through the sewer system and evaluate system response to support development of an optimal capital improvement program.

Powerful, comprehensive and user-friendly, *RDII Analyst* reflects Innovyze® Inc's time-honored practice of continually adding value to its world-class software and bringing critical new design capabilities to the industry. We are happy to bring you the state-of-the-art in RDII flow analysis and management technology to help you accurately analyze and manage your infrastructures. Our high-level, state-of-the-art research and development effort is continuing at a rapid pace and we intend to update and refine *RDII Analyst* to reflect this progress.

We are pleased to be at the forefront of this computer technology and to continue to advance it to an unprecedented level of reliability and performance. In months to come, *RDII Analyst* will grow to include even more features that are powerful and make your work more efficient and effective.

Colby T.

Manwaring, P.E.

Chief Executive Officer, Innovyze Inc.

Portland, Oregon USA January 30, 2019

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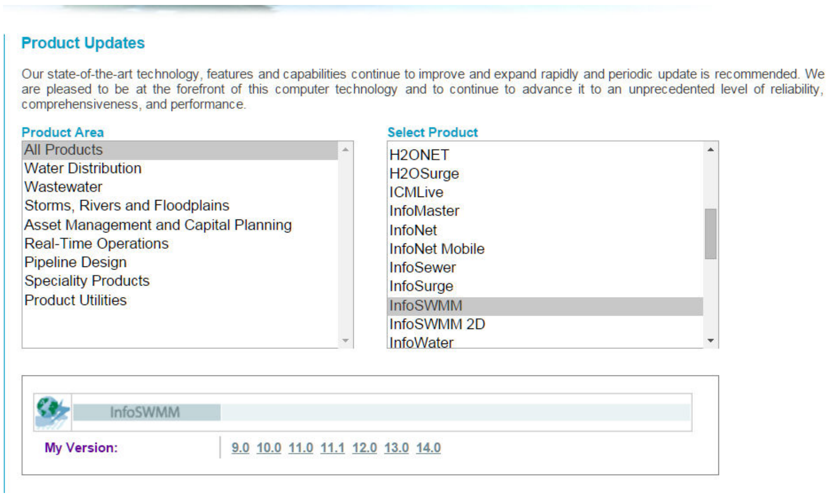
Installation Guide

System Requirements for InfoSWMM w ArcGIS, H_2OMap SWMM does not need ArcGIS	
Compatible 32-bit OS:	Windows Server 2008 R2, Windows Server 2012 R2, Windows 7/8/8.1/10 pro or above
Compatible 64-bit OS:	Windows Server 2008 R2, Windows Server 2012 R2, Windows 7/8/8.1/10 pro or above
Compatible ArcGIS:	10.0, 10.1, 10.2 and 10.3 - 10.4 (**Check your PC ability to run ArcGIS**)
Prerequisites:	**Microsoft Visual C++ 2008 Redistributable - x64 v9.0.30729.17**/**Microsoft Visual C++ 2008 Redistributable - x86 v9.0.30729.17**, **Microsoft Visual C++ 2010 Redistributable - x86 v10.0.40219.1**/**Microsoft Visual C++ 2010 Redistributable - x64 v10.0.40219.1** and **Windows Internet Explorer 7 or later**
Hardware Requirements:	CPU Speed: 2.2 GHz minimum or higher; Hyper-threading (HHT) or Multi-core recommended Processor: Intel Pentium 4, Intel Core Duo, or Xeon Processors; SSE2 (or greater) Memory/RAM: 2 GB or higher Screen Resolution: 1024 x 768 recommended or higher at Normal size (96dpi) Disk Space: 500 MB of free space to accommodate a full setup installation and additional disk space - keep as much free disk space available as possible. Its virtual memory system needs additional free disk space when working on large projects Video/Graphics Adapter: 64 MB RAM minimum, 256 MB RAM or higher recommended. NVIDIA, ATI and INTEL chipsets supported Networking Hardware: Simple TCP/IP, Network Card or Microsoft Loopback Adapter is required for the License Manager

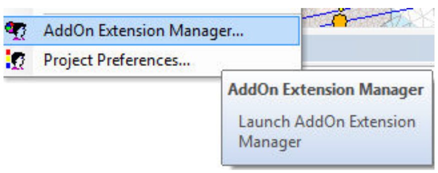
Installing Innovyze Software Add On's and Extensions

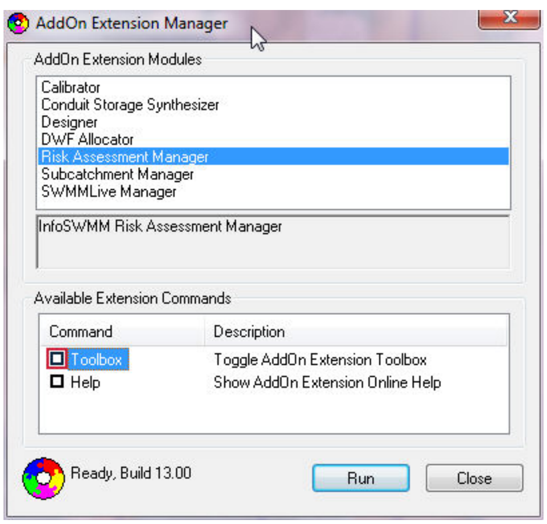
Innovyze programs can only be installed from our Internet website. To install this program or a single user, perform the following procedure:

- Turn on your computer and start Windows. Close any other applications that are currently running.
- Start your Internet Browser software and go to http://www.Innovyze.com. Once on Innovyze® Inc's homepage, please go to http://www.innovyze.com/updates/ Choose the *program* tab and click on the link. This will launch the File Download dialogue box.
- Choose the *SAVE THIS PROGRAM TO A Directory* option and follow the on-screen instructions. When saved on your hard drive run the Execute (*.exe) file from the folder that was downloaded and follow the on-screen instructions.



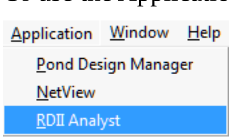
Upon successful installation of the program, the program is initialized from inside InfoSWMM by using the “AddOn Extension Manager” tool. From the Tool Menul, select an Add On as shown below.

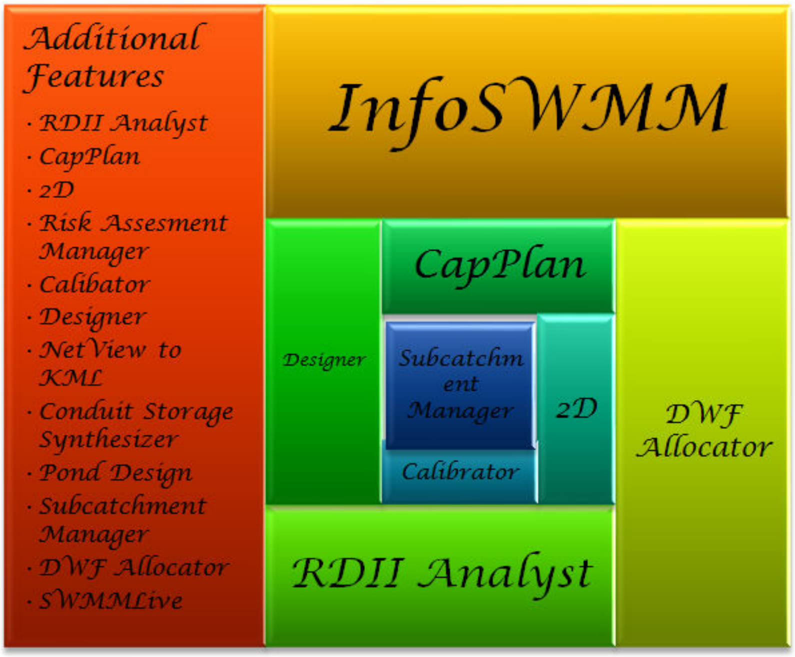




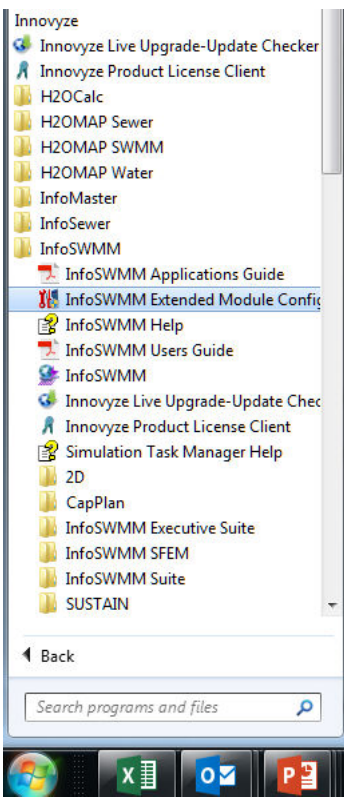
The selected run dialog appears, and it is now available for use. Section 2 discusses each icon and the menu shown below in detail. This program is part of the InfoSWMM Suite.

Or use the Application Window where there are additional AddOns for InfoSWMM





If you do not see the AddON's or Applications for the InfoSWMM Suite version of then you can use the InfoSWMMExtended Module Configuration from Windows Start.



Using the On Line Help

Innovyze provides on-line Help with extensive information about modeling features and capabilities. The documentation includes numerous topics, each including narrative descriptions, illustrations, and diagrams describing the features of each program.

The on-line Help offers the ability to search for a desired topic rapidly or to move between related topics in a fast, efficient manner. An extensive index is available allowing you to search on any number of words, phrases, or commands. Innovyze Help includes several major sections, each identified by a magenta book in the Help Contents. Each section contains numerous related topics.

StartingInnovyze Help

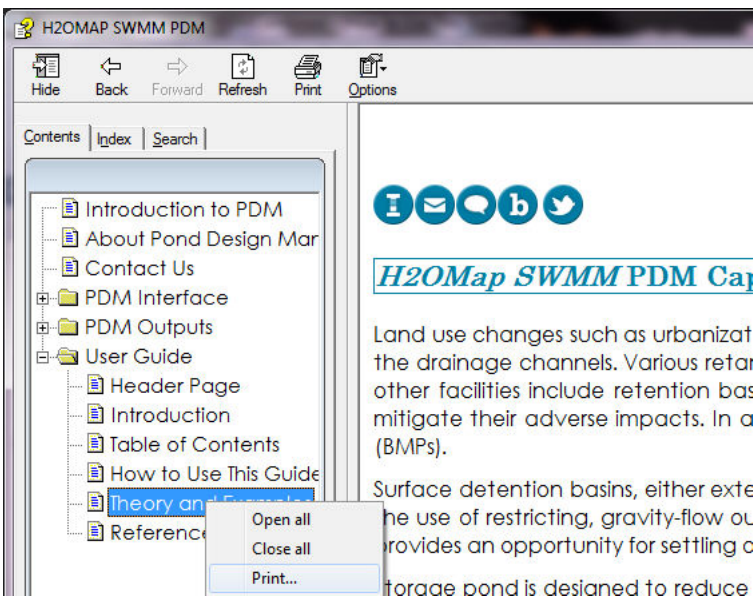
Innovyze Help is available by opening any Innovyze dialog box and pressing the F1 key. You may click on any portion of the dialog box in the help topic for more information.

Navigating the On Line Help

Use either Innovyze Help Contents or the Index to navigate to the desired topic. Choose the Help Topic button in the upper left-hand corner of the Help window to access the Help contents and index. Embedded in the text of each topic are numerous *links*, identified as underlined blue text, to related topics. Simply click on the desired link text with the mouse to move immediately to the related topic.

Printing the OnLine Help

You may print any Innovyze Help topics you desire. To do so, navigate to the desired Help topic and then choose the Print Topic command from the Help window File menu.



Instructions to Renew the CD and License Keys for the Innovyze (MWH Soft) Floating License Server

Below are instructions to renew the CD and License Keys for the Innovyze (MWH Soft) Floating License Server and the floating licenses to reflect the current expiration date.

1. Open the Innovyze (MWH Soft) Floating License Server.
2. Go to the **Help** -> **About** menu in the upper left corner.
3. Go to the Request License Key On-line for dropdown menu and select Renewal. Press the **Go** button. This will open our On-Line License Registration page.

4. Complete the requested information and press the **Submit** button. This should return to you a new CD Key and License Key.

5. Copy and paste the new keys into the appropriate boxes in the **About** dialog box.

6. Press the **Apply License Changes** button. A new Subscription Expiration Date should appear.

7. Close the **About** box and the Innovyze (MWH Soft) Floating License Server.

8. Download and run the update for the Innovyze (MWH Soft) Floating License Server from the attached link:

- Innovyze Floating License Server 5.0 Update 020 (22.03 MB), 12/10/2015

9. Open the Innovyze (MWH Soft) Floating License Server.

10. If your FLM is installed on a virtual server, go to the upper left corner and select **Action** -> **Register Virtual Environment …**

11. Select the License Administration tab.

12. Go to the Request License Key On-Line for dropdown menu and select **Renewal**. Press the **Go** button. This will open our On-Line License Registration page.

13. Complete the requested information and press the **Submit** button. This should return to you a new CD Key and License Key.

14. Copy and paste the new keys into the appropriate boxes in the License Administration tab.

15. Press the **Apply** button. A new Expiration Date should appear.

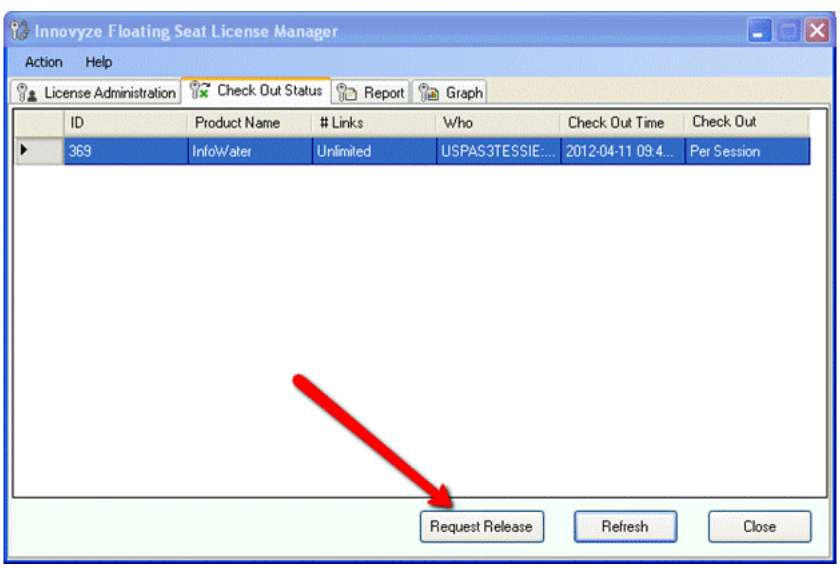
Press the Close button

Please follow the instructions below to request a license release key for a floating license.

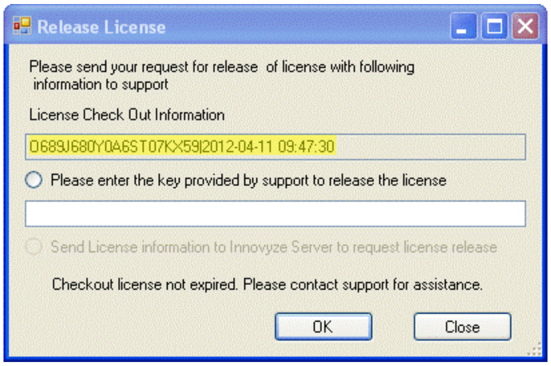
Please follow the instructions below to request a license release key for a floating license. Most likely this will need to be forwarded to someone who has access to the Innovyze Floating Seat License Manager on a server.

- Open the Innovyze Floating Seat License Manager and select the Check Out Status tab.

- Select the license to release and press the Request Release button.



Copy the License Check Out Information generated and paste into an email to support@innovyze.com



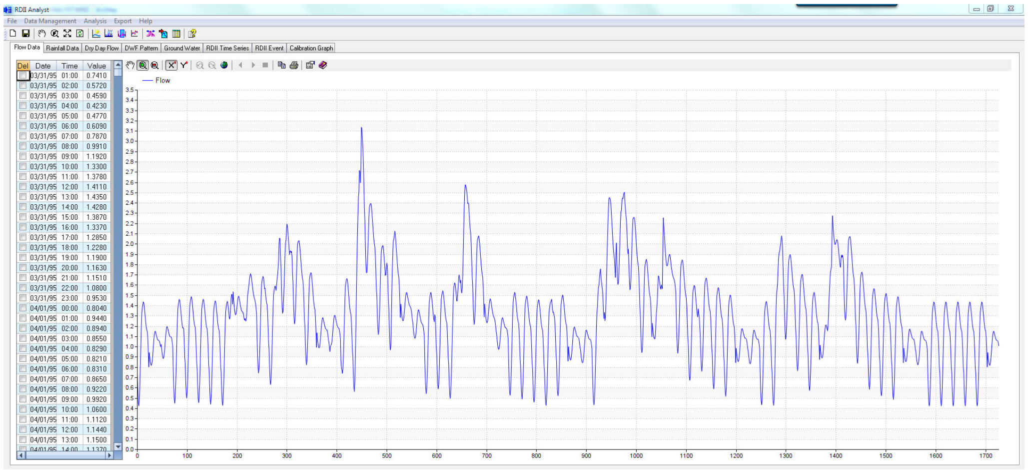
- We will return to you a code to enter in to the second field.
- Once both fields are populated in the Release License dialog box, press the OK button to release the license.

Technical Support On the Web and by Email

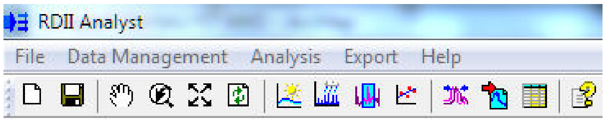
See the Help file Topic Contact Us for detailed Innovyze Technical Support information.

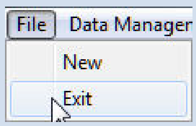
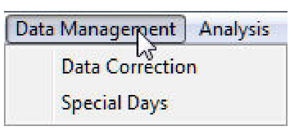
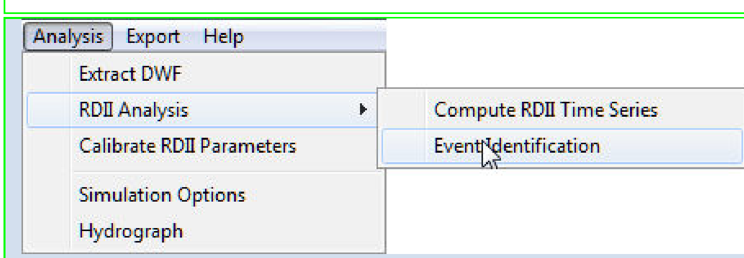
2.2 The Core Interface

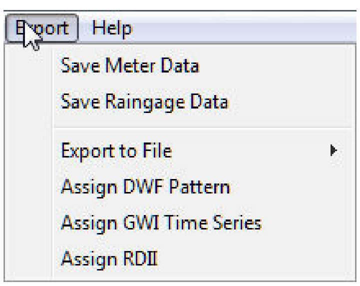
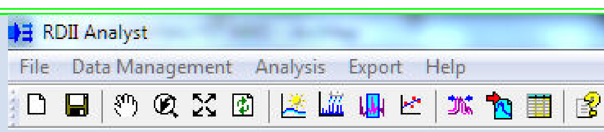
The *RDII Analyst* interface, shown below, consists of menus, tool bars, and buttons that are created to simplify various analysis processes. *RDII Analyst* can be launched from InfoSWMM > *Application* -> *RDII Analyst.*



RDII Analyst Menus

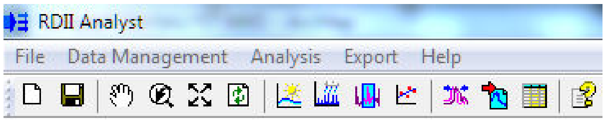


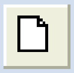
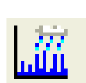
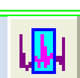
Menu	Name	Description
	**File Menu**	Use the *New* option to define flow data and rainfall data and to begin decomposition process. Use *Exit* to close the *RDII Analyst*.
	**Data Management Menu**	Functionalities under this menu are used to perform QA/QC of the flow data and the rainfall data. The *Data Correction* option is used to edit/delete suspicious data values and flow data corresponding to special days such as holidays.
	**Analysis Menu**	The features provided in this menu help decompose the corrected flow data into dry

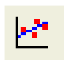
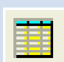
		weather flow (DWF), groundwater (GWI) and RDII flow. Calibration of the RTK parameters can also be launched from this menu.
	**Export Menu**	The export menu may be used to export the extracted DWF, GWI and RDII time series to *H2OMAP SWMM* and to assign these flow types to the nodes that contribute flow to the meter location. Some analysis results can also be exported to text file. The exported flow types may be used to model the collection system using *H2OMAP SWMM*.
	**Help Menu**	The help menu is used to access the help file that describes how

		to use the *RDII Analyst* functionalities.

RDII Analyst Tools



Button	Name	Description
	**New**	Is used to create new RDII analysis project. It will launch the dialog box used to define new flow data and rainfall data files. The New Button launches the New Analysis Dialog Box where new flow and rainfall data file locations are input.
	**Save**	Is used to save changes made to the flow data and the raingage data tables in the Flow Data Tab and the Rainfall Data Tab back to the respective data base files.
	**Pan**	Is used to move across the graphs time axis and helps to better visualize the data values. A Graph Control Toolbar is also provided to manage the graph display.
	**Zoom Previous**	Zooms to previous view of graph.
	**Zoom to Full Extent**	Zoom the graph to the full extent of the data
	**Refresh**	Refreshes the graphs based on the latest changes made to the data
	**DWF Extract**	Extracts the DWF component from the flow data. It is also accessible from the Main Menu with the Analysis> DWF Extraction command. See the Analysis Menu. This tool button starts the Dry Weather Flow Extraction process.
	**Compute RDII Time Series**	Extracts the RDII Time Series from the Flow data the DWF time series and the GWI time series determined from previous steps. It is also accessible from the main menu with **Analysis> RDII Analysis> Compute Time Series>**.
	**RDII Event Identification**	Launches the RDII Event Identification dialog box to set the parameters to calculate the Event Graph. A linear regression between the RDII Depth and the

		Rainfall Depth will be displayed. This command is accessible from the main menu with the **Analysis> RDII Analysis> Event Identification>** command.
	**Event Graph**	Displays a graph showing the linear regression between RDII volume and rainfall volume for RDII events identified using RDII Analyst. Displays the results of the **Analysis> RDII Analysis> Event Identification>** analysis.
	**RDII Calibration Parameters**	Launches the RDII calibration parameters dialog box to define the RTK parameter ranges and sewershed area for the tributaries.
	**Run Once**	Whereas the RDII Calibration Parameters tool uses GA and may iterate thousands of times, using this tool completes only one iteration using the current RTK parameters associated with the hydrograph
	**Calibration Report**	Launches the Calibration Report dialog box. This button shows the results of the Calibrate RDII Parameters analysis.
	**Help**	Launches the online help file

RDII Analyst Graphs and Reports

TAB	Description
Flow Data	Presents the flow data in report and graph form
Rainfall Data	Presents the rainfall data in graph and report form
Dry Day Flow	Presents the DWF flow time series in graph and report form
DWF Pattern	Presents hourly DWF patterns for weekdays and weekend in graph and report form
Ground Water	Presents GWF times series in report and graph form
RDII Time Series	Presents RDII time series in graph and report format
RDII Event	Presents RDII event information in report format
Calibration Graph	Provides graphical comparison of the RDII time series extracted by the RDII analysis from the flow data and the RDII flow simulated by the model based on the calibrated RDII unit hydrograph parameters

Innovyze Help File Updated January 30, 2019

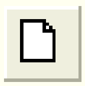
InfoSWMM uses the EPA SWMM 5.1.013 Engine

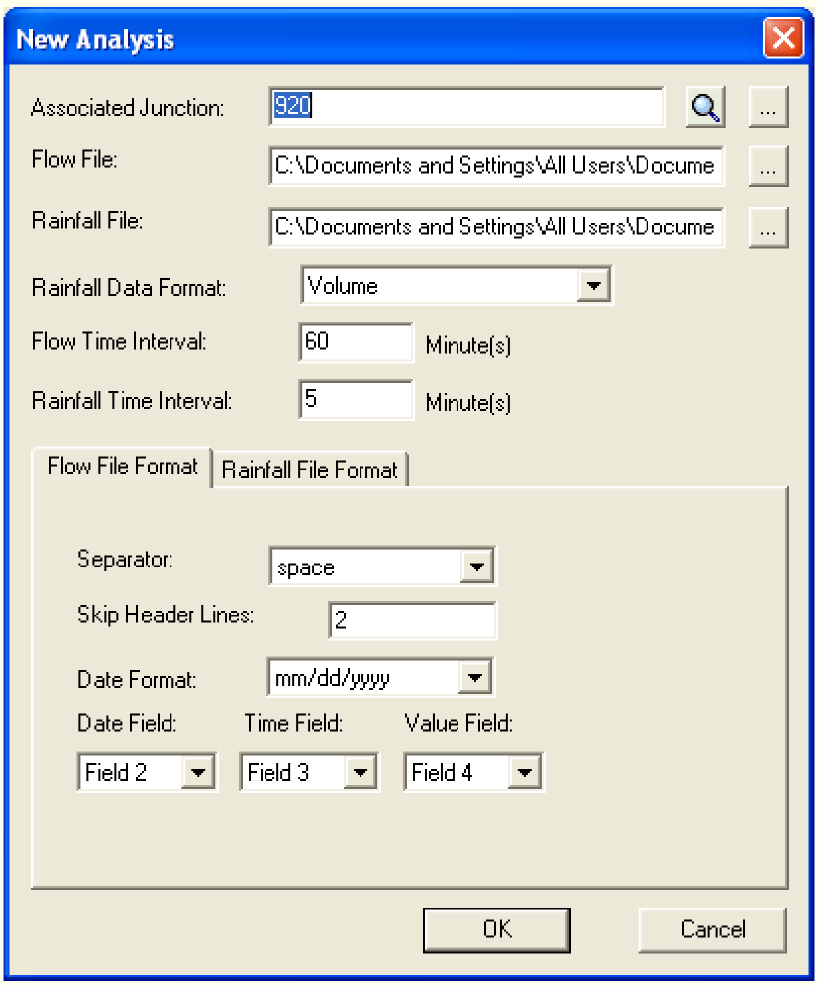
More Questions? Further Help Can be Found by Emailing Support@Innovyze.com

or by Using Our Social Media Websites or Searching the Internet for #INFOSWMM

InfoSWMM

2.3 Defining Flow and Rainfall Data

RDII Analyst reads flow monitoring data and the corresponding rainfall data, and performs a series of analyses to decompose the flow monitoring data into DWF, groundwater flow (GWI) and RDII flow components. Various flow data and rainfall data formats are accepted. The data files and the data formats are specified using the *NEW ANALYSIS* dialog editor shown and described below. The dialog can be launched from *File -> New* or by clicking () from the toolbar.



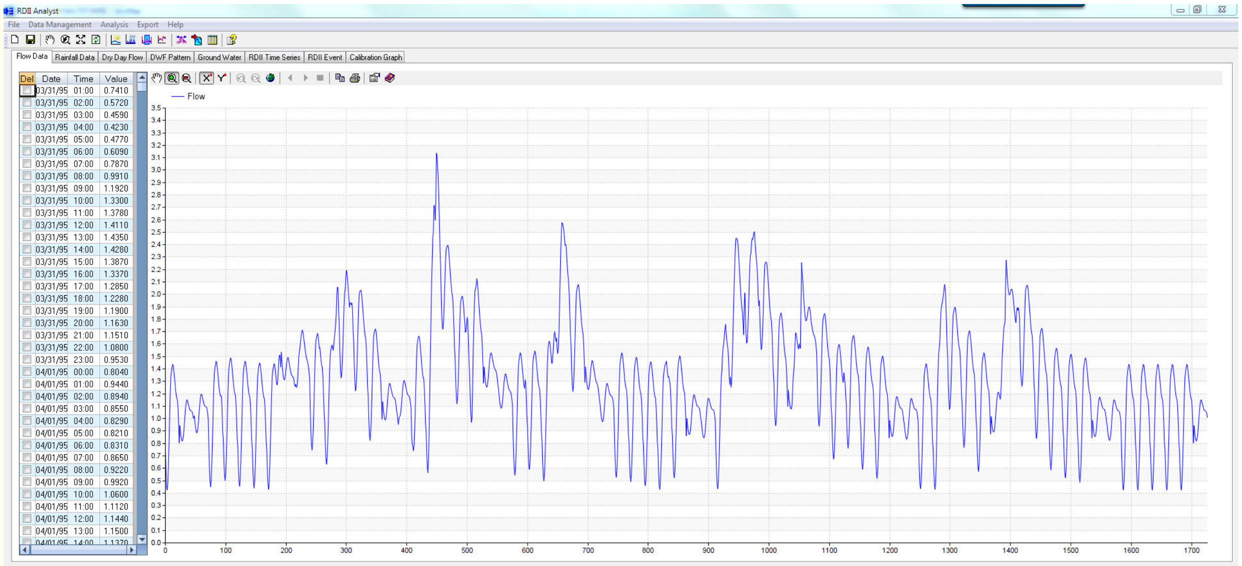
Name	Description

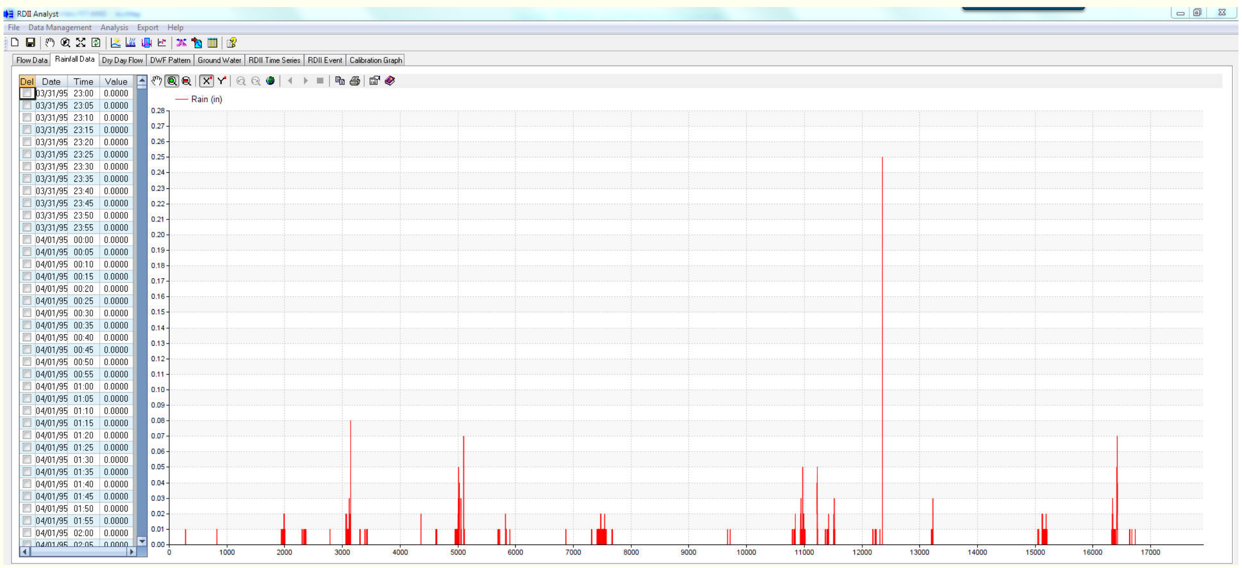
Associated Junction	Enter the junction ID or use the Browse (…) button to locate the flow monitoring site on the Map View.
Search ( )	An input profile is saved after a successful import. Click this button to search for the profile for the Associated Junction.
Flow File	Enter the path or use the Browse (…) button to locate the flow data file.
Rainfall File	Enter the path or use the Browse (…) button to locate the rainfall data file.
Rainfall Data Format	Specify if the rainfall data represents rainfall intensity, rainfall volume over the rainfall time interval or, a cumulative rainfall over time.
Flow Time Interval	Select the time interval at which the flow data is measured.
Rainfall Time Interval	Select the time interval at which the rainfall data is measured.
OK	Select OK after all fields are entered to start the data import process.
Cancel	Select Cancel to abandon all changes and return to the RDII Analyst.
Flow & Rainfall File Format Tabs	
Separator	Select the field

	separator used in the data file. This determines how the data columns are separated from one another in a row. Comma, tab, space, colon and semicolon are supported.
Skip Header Lines	Number of header lines to skip when reading the data file.
Date Format	Select the date format used for the flow monitoring data. The following formats are supported: 
Date Field	Select data column (field) that contains the date field.
Time Field	Select data column that contains the time field.
Value Field	Select the data column that contains the flow values.

Once the above information is specified for the flow monitoring data and rainfall data, then click the **OK** button.

The monitoring data and the rainfall data will be processed and presented both graphically and in report form in the Flow Data Tab and the Rainfall Data Tab:





QA/QC may be performed on the flow data and the rainfall data to ensure that suspicious data values are removed, and if necessary, special dates such as holidays that do not represent typical DWF days are removed from the data.

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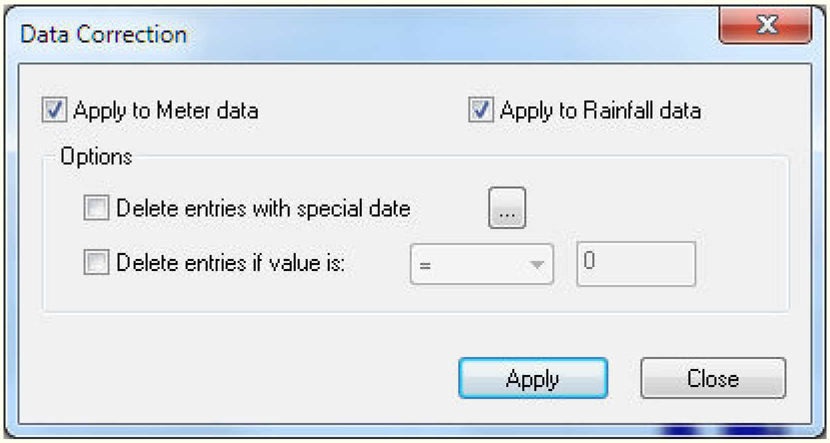
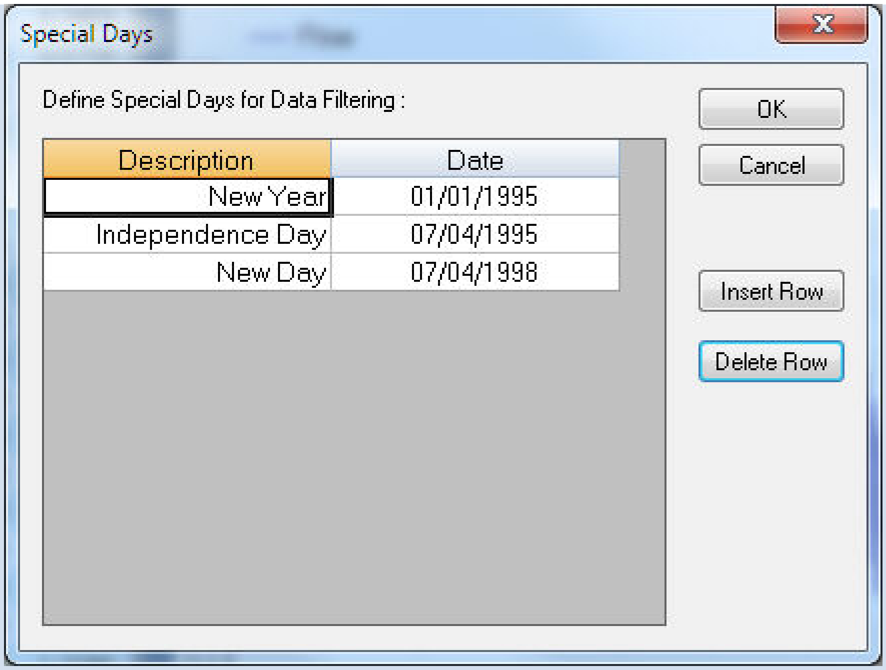
2.4 QA/QC of Flow Data and Rainfall Data

The flow data and the rainfall data read into *RDII Analyst* may be corrected using the *DATA CORRECTION*

feature available from *DATA MANAGEMENT* menu. In addition to the date correction options described below, the user can manually edit/delete data rows as needed and save the changes.



Name	Description
Apply to Meter Data	Check the option to apply data correction to flow data
Apply to Rainfall Data	Check the option to apply the data correction to rainfall data
Delete entries with special date	If checked, this option deletes data corresponding to the days defined as *Special Days*

	
Delete entries if value is	This option is designed to delete rows with values that are used as a code for missing data or null data

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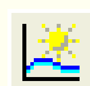
2.5 Decomposing the Corrected Flow Data

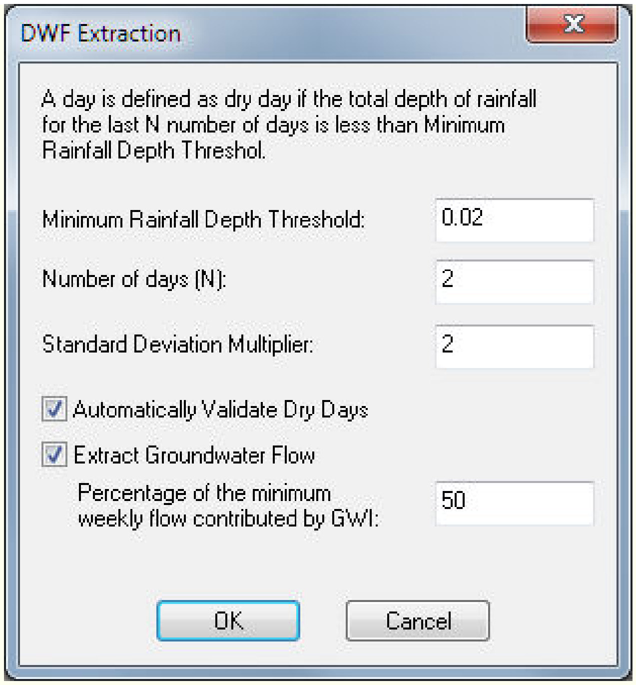
The corrected flow data can be decomposed into its DWF, GWI, and RDII flow components with the help of the rainfall data. The decomposition process is illustrated in this section.

Determining the DWF Component

The first step towards determining the DWF

component of the flow data is to identify dry days and wet days. The objective is to extract dry days (i.e., days not affected by precipitation) from the flow data, and to perform DWF analysis on these dry day flows. A day is defined as a dry day if the total depth of rainfall for the last user defined number of days is less than a given threshold. The presumption is that if there is no rain for extended number of days, the measured flow data represents the DWF component and the GWI component, but not the RDII flow component. The DWF component identified using this criterion can be further analyzed and verified manually or guided by statistical tools available from RDII Analyst.

The DWF Extraction inputs are specified on the DWF Extraction dialog editor shown below. The editor can be launched either from Analysis Menu -> DWF Extraction or from DWF Extraction tool ().

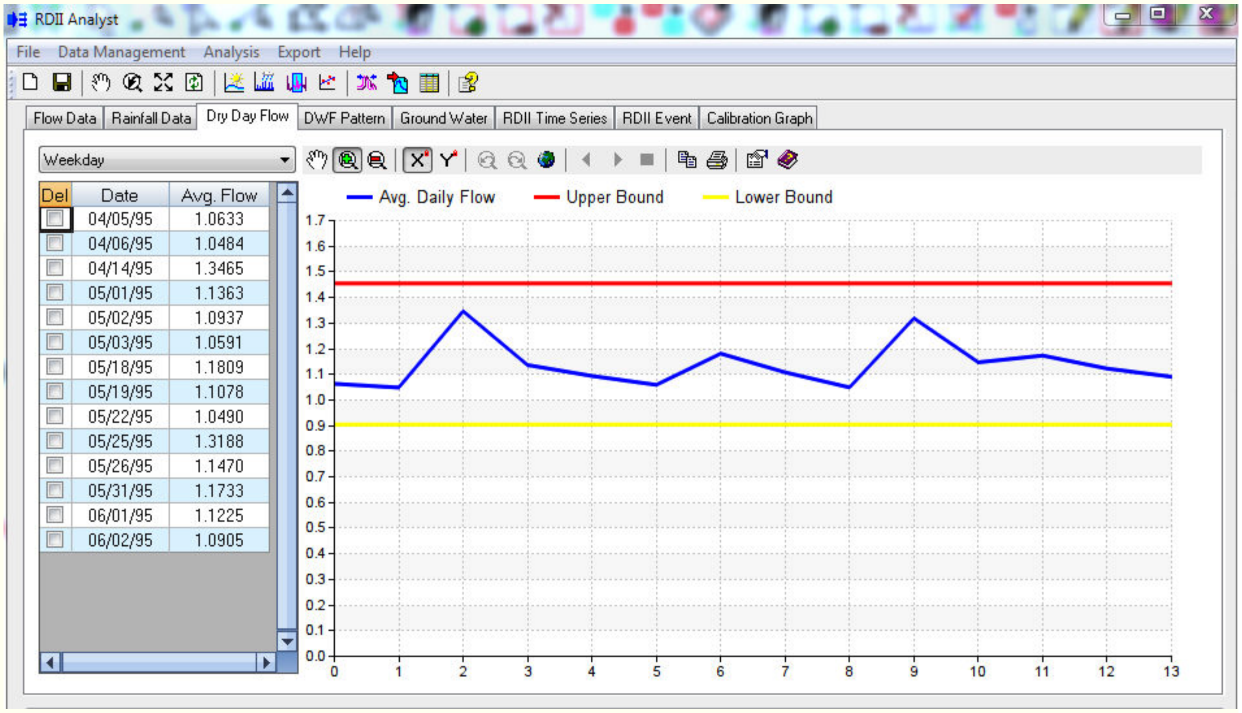


Minimum Rainfall Depth Threshold: refers to the cumulative volume of rain that should not be achieved or exceeded over the last N Number of Days for a day to be defined as a dry day, otherwise the day is defined as a wet day.

Standard Deviation Multiplier -Days categorized as dry days based on Minimum Rainfall Depth Threshold and Number of Days (N) criteria may be further verified guided by statistical parameters such as the mean and the standard deviation of flow values for the identified dry days. If flow value for dry day X is less than mean minus standard deviation multiplier* the standard deviation or higher than mean + standard deviation multiplier* the standard deviation, then that flow value may be an outlier (i.e., it may not be a representative dry day value). If that happens, the user has the option to discard the day from the dry day list. If the Automatically Validate Dry Days option is checked, then the program automatically discards dry days that meet the criterion. Otherwise, the user can manually delete dry days that are outliers.

Once determined, the dry days flows are presented both in report form and in graph form for weekend and for weekdays as shown below. The graph shows average daily flow for each dry day, and upper bound and the lower bounds. The upper bound refers to mean flow of all dry day flows plus standard deviation multiplier *standard deviation of dry day flows. The lower bound refers to mean flow of all dry day flows minus standard deviation multiplier *standard deviation of dry day flows.

The bounds help the user visually identify outliers and, if necessary, discard those days from further consideration.

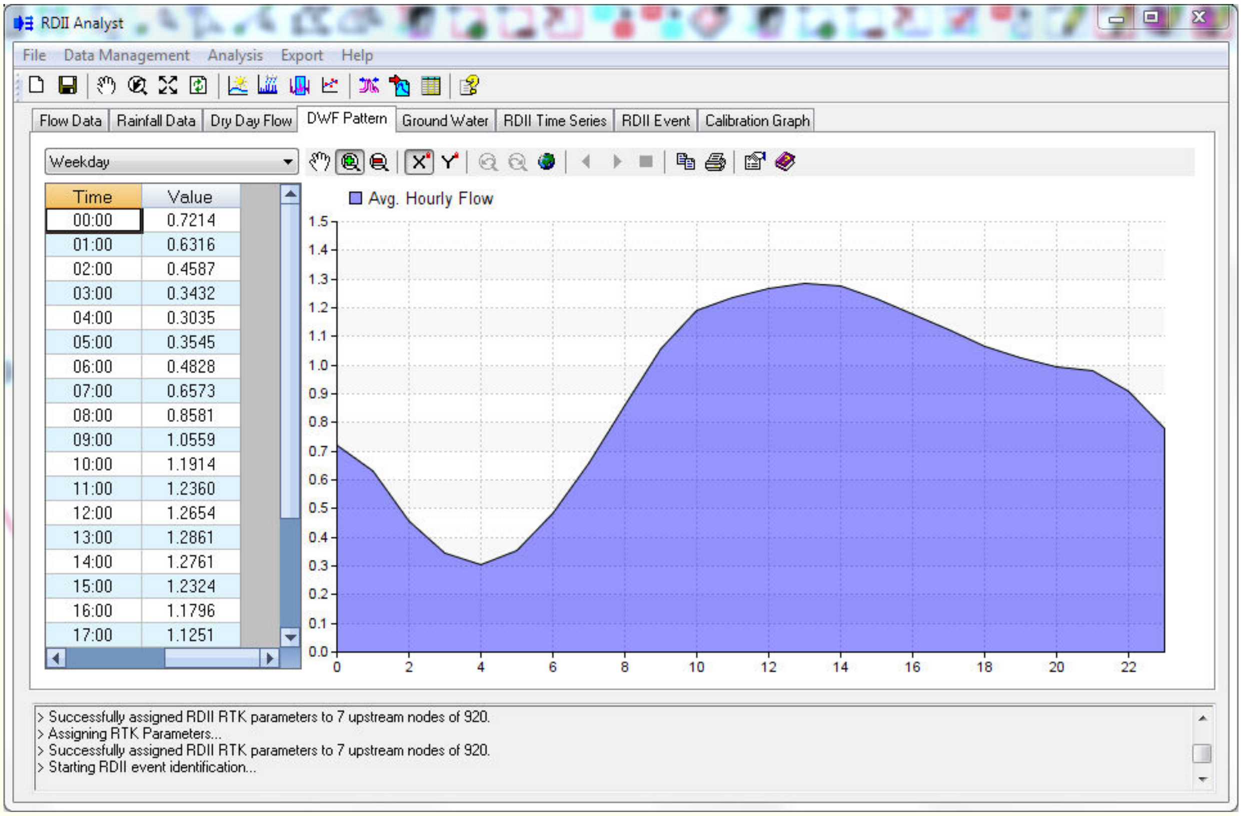


The dry day flows identified for weekdays and the weekend are further analyzed to determine hourly DWF patterns that can be used to model DWF in InfoSWMM .

The DWF pattern presents average hourly DWF values across all dry days for both weekdays and weekend. The DWF pattern is given both graphically and in report form as shown below.

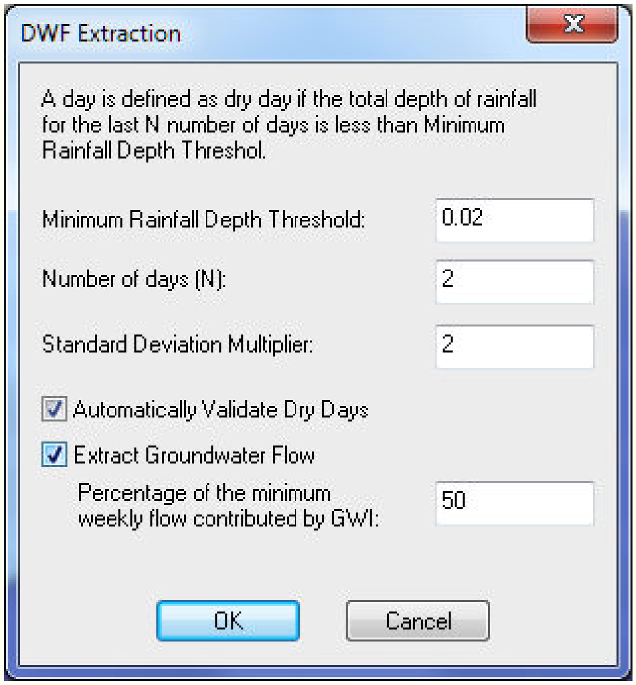
The DWF patterns can be exported toInfoSWMM

and are assigned to nodes that contribute flow to the meter location proportional to sewershed area or equally among all nodes. Detailed description of how to export DWF patterns and the available options will be described in another section later in this chapter.

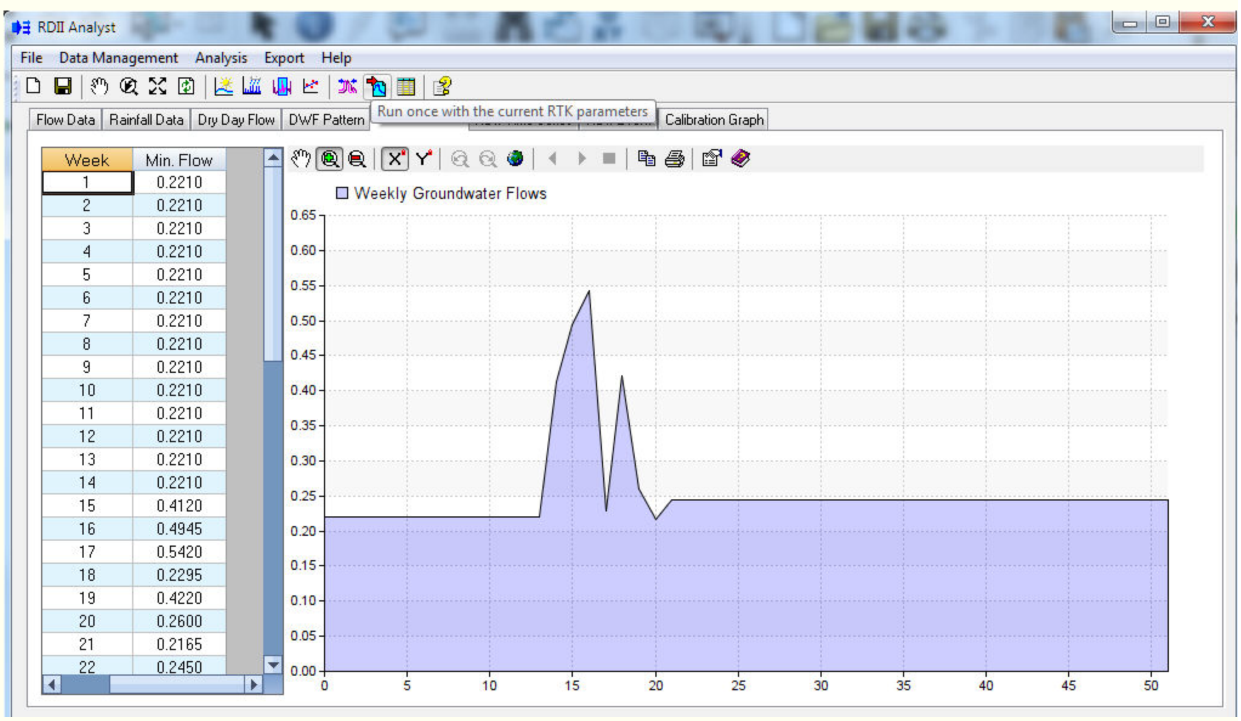


Determining the Groundwater Flow Component

In areas where groundwater table is high (i.e., close to ground surface), groundwater flow may enter sewer systems through pipe cracks, through joints or through manhole covers. Groundwater flow to sewer systems may not show significant variability with time. In *RDII Analyst*, groundwater component is assumed as the minimum weekly flow extracted from the dry days. The minimum weekly dry day flows can be adjusted by a user-defined multiplier that is defined using the *DWF Extraction* dialog editor previously described. To extract the groundwater flow component, you need to check the *Extract Groundwater Flow* option and then assign a value for *Fraction of the minimum weekly flow contributed by GW.*



Fraction of the minimum weekly flow contributed by GWI: This multiplier adjusts the weekly minimum flows extracted from the dry day flows. The product of this multiplier and the minimum weekly flows would be reported as groundwater flow contribution. Once the analysis is complete, GWI component is presented graphically and in report form as shown below.



The groundwater flow time series can be exported toInfoSWMM

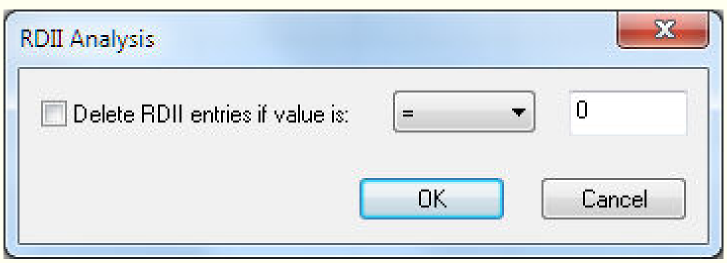
as external inflow and can be assigned to nodes that contribute flow to the meter location proportional to sewershed area or equally among all nodes. Detail description of how to export groundwater flow time series will be described in another section later in this chapter.

Determining the RDII Flow Component

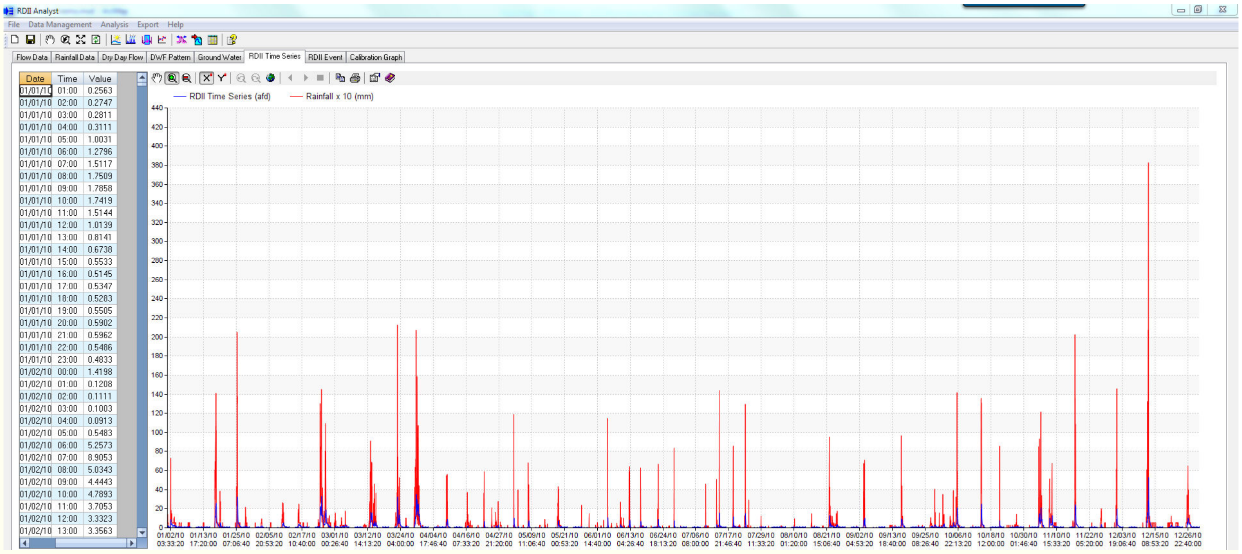
RDII flow is the difference between the corrected monitoring flow data, and the sum of average hourly DWF pattern and the groundwater flow time series. Once the hourly DWF pattern and the groundwater flow components are identified, the sum of the two components would be subtracted from the corrected flow data to determine the RDII flow component.

RDII time series evaluation can be launched by clicking the () button on the toolbar or from the menu using *Analysis -> RDII Analysis -> Compute RDII Time Series*.

Extraneous RDII values can be eliminated by setting the correct parameters in the following dialog:



Clicking **OK** will produce the RDII Time Series:



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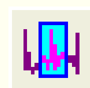
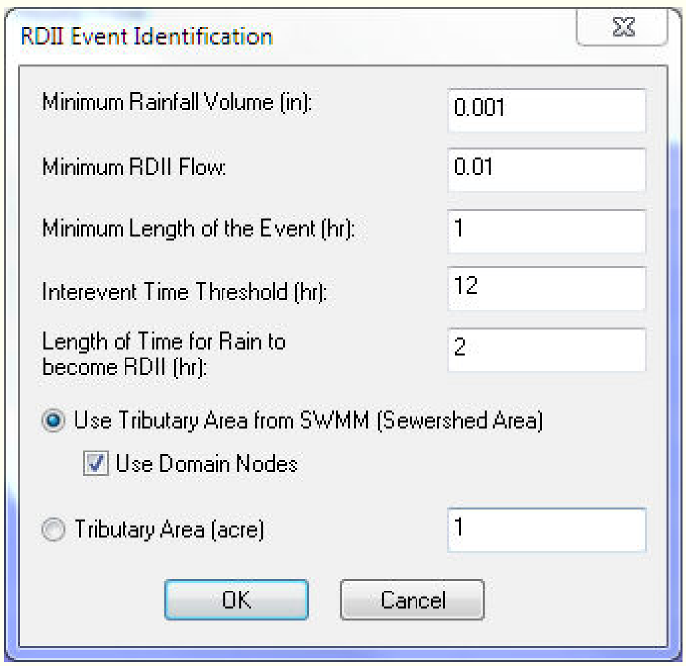
2.6 Identifying RDII Events

RDII Analyst can further analyze the RDII time series to identify RDII events. Breaking RDII time series into separate events can enable a better understanding of the RDII process and aid in process of calibrating the model. Event definition depends on the values assigned for the inputs given in the *RDII EVENT IDENTIFICATION*

dialog box shown below. Click the () button from the toolbar to launch the dialog box.



Minimum Rainfall Volume: represents the minimum rainfall depth that needs to be collected from "continuous"

rain to initiate an event. By continuous rain, it means that for two rainfall occurrences to be considered as one event the time interval between the successive rains should not exceed the *interevent time threshold* defined by the user.

Minimum RDII Flow: represents the minimum RDII flow that should be generated as the result of the rainfall collected over the duration to accept the occurrence as an event.

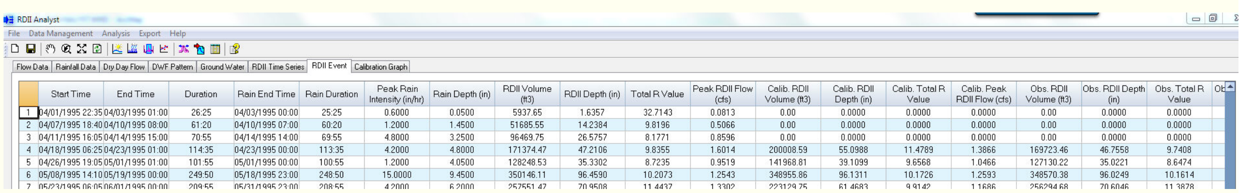
Minimum Length of the Event (hr): refers to the minimum length of time that the RDII flow should exceed the *minimum RDII flow* for the occurrence to be accepted as an event.

Interevent Time Threshold (hr): refers to the length of time needed to separate two successive events. If two rainfall occurrences are separated by duration shorter than the *Interevent Time Threshold*, then the two rainfall occurrences are considered as one event.

Length of Time for Rain to become RDII (hr): This input refers to average time span for a rainfall event to start contributing RDII to the collection system. Depending on this input, the RDII event identification algorithm tests if an RDII flow has occurred within the *Length of Time for Rain to become RDII (hr)* after a rainfall event.

Tributary Area: This input is used to compute RDII flow depth based on RDII flow volume determined for each event. *RDII Analyst* can use the sewershed area defined in InfoSWMM 's RTK Hydrograph page, or the user can directly specify area of the tributary sewersheds. In addition, the user has the option to use sewershed area of the nodes defined in a domain. If the *Use Domain Node* option is checked, sewershed area of the nodes included in the domain will be considered. Nodes in the domain will not contribute sewershed area.

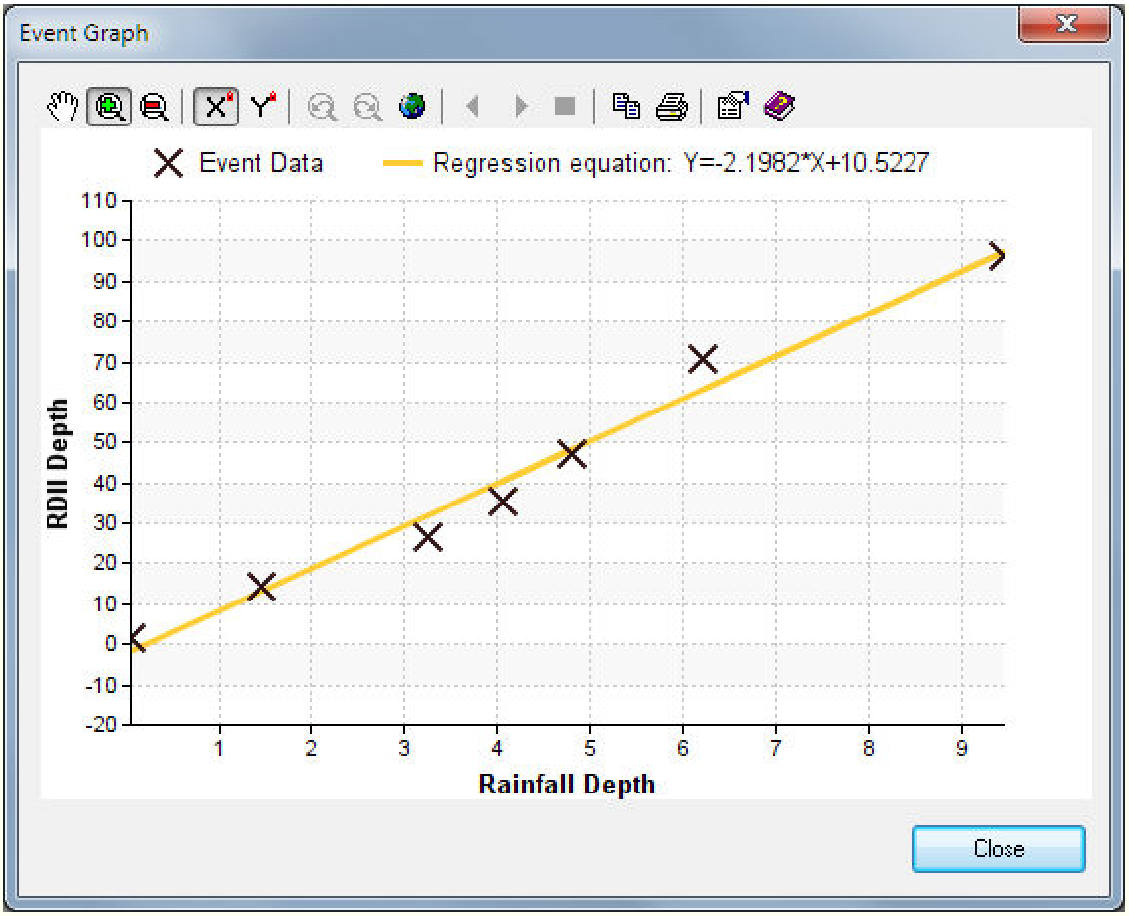
RDII Event Analysis Results: The identified RDII events are summarized as shown below.



	Start Time	End Time	Duration	Rain End Time	Rain Duration	Peak Rain Intensity (in/hr)	Rain Depth (in)	RDII Volume (ft3)	RDII Depth (in)	Total R Value	Peak RDII Flow (cfs)	Calib. RDII Volume (ft3)	Calib. RDII Depth (in)	Calib. Total R Value	Calib. Peak RDII Flow (cfs)	Obs. RDII Volume (ft3)	Obs. RDII Depth (in)	Obs. Total R Value
1	04/01/1995 22:35	04/03/1995 01:00	26:25	04/03/1995 00:00	25:25	0.6000	0.0500	5937.65	1.6357	32.7143	0.0813	0.00	0.0000	0.0000	0.0000	0.00	0.0000	0.0000
2	04/07/1995 18:40	04/10/1995 08:00	61:20	04/10/1995 07:00	60:20	1.2000	1.4500	51685.55	14.2384	9.8196	0.5066	0.00	0.0000	0.0000	0.0000	0.00	0.0000	0.0000
3	04/11/1995 16:05	04/14/1995 15:00	70:55	04/14/1995 14:00	69:55	4.8000	3.2500	96469.75	26.5757	8.1771	0.8596	0.00	0.0000	0.0000	0.0000	0.00	0.0000	0.0000
4	04/18/1995 06:25	04/23/1995 01:00	114:35	04/23/1995 00:00	113:35	4.2000	4.8000	171374.47	47.2106	9.8355	1.6014	200008.59	55.0988	11.4789	1.3866	169723.46	46.7558	9.7408
5	04/26/1995 19:05	05/01/1995 01:00	101:55	05/01/1995 00:00	100:55	1.2000	4.0500	128248.53	35.3302	8.7235	0.9519	141968.81	39.1099	9.6568	1.0466	127130.22	35.0221	8.6474
6	05/08/1995 14:10	05/19/1995 00:00	249:50	05/18/1995 23:00	248:50	15.0000	9.4500	350146.11	96.4590	10.2073	1.2543	348955.86	96.1311	10.1726	1.2593	348570.38	96.0249	10.1614
7	05/23/1995 06:05	06/01/1995 00:00	209:55	05/31/1995 23:00	208:55	4.2000	6.2000	257551.47	70.9508	11.4437	1.3302	223129.75	61.4683	9.9142	1.1686	256294.68	70.6046	11.3878

Linear Regression Results: A linear regression equation is developed between the RDII depth and rainfall depth identified for each event. Slope of the regression equation represents the fraction of rainfall depth that enters the sewer system in the form of RDII (i.e., a representative R for all events). The Linear Regression Results can be seen by clicking the () button from the toolbar. The Regression analysis result is

given graphically.



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2.7 RDII Calibration

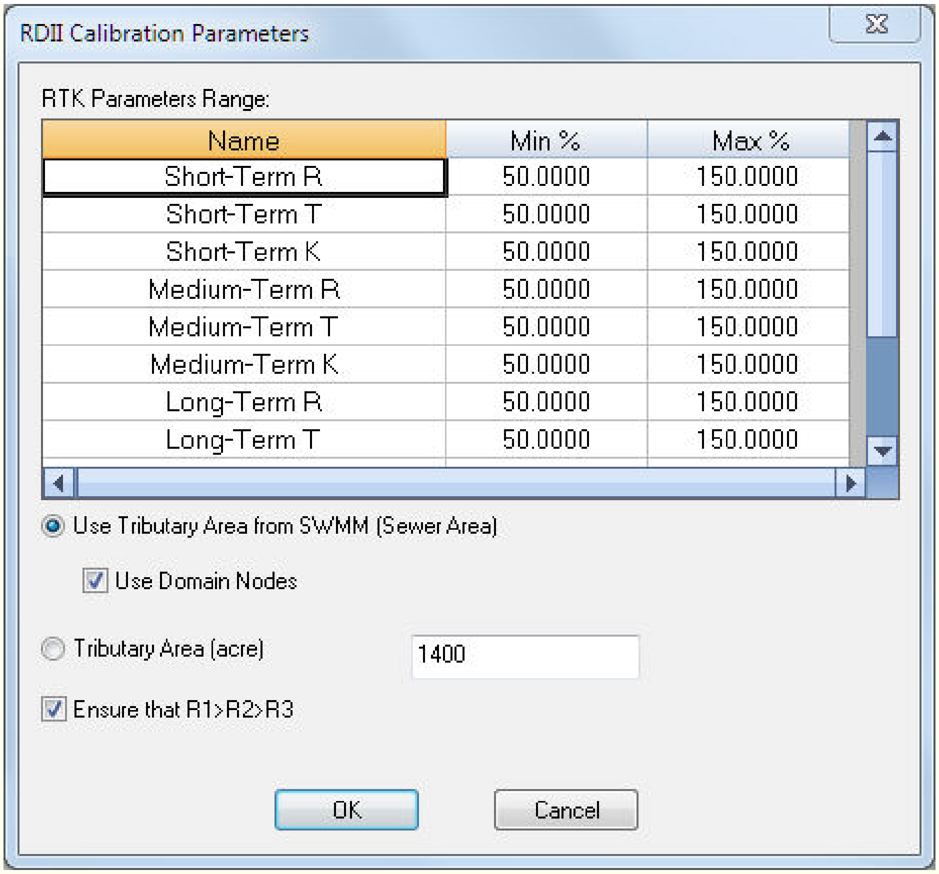
One of the objectives of decomposing flow monitoring data into dry weather flow and wet weather flow components is to improve the accuracy of modeling the wet-weather flow component.

In InfoSWMM ,

RDII flow is modeled using the RTK method as previously described. The RTK method requires definition of up to 12 parameters. Proper choice of these parameters is crucial for accurate modeling of the RDII flow. Traditionally, RDII UH parameters are assigned using a tedious and inexact trial-and-error process in which the parameters are manually adjusted in an iterative fashion to closely match wet-weather flow data with the RDII flow generated by the simulation model using the assumed RTK parameters. Since there are a vast number of possible combinations of RTK values, evaluating all options this way may not be manageable, and even knowledgeable modelers often fail to obtain good results. *RDII Analyst* uses Genetic Algorithms (GA) optimization to automatically determine the UH parameters that best match the RDII time series generated by the *RDII Analyst* with the RDII flow estimated using InfoSWMM .

The RDII calibration tool is launched using *Analysis -> Calibrate RDII Parameters* or using from tools.

Minimum and maximum value for each parameter should be defined using the *RTK Parameters Range* dialog editor.



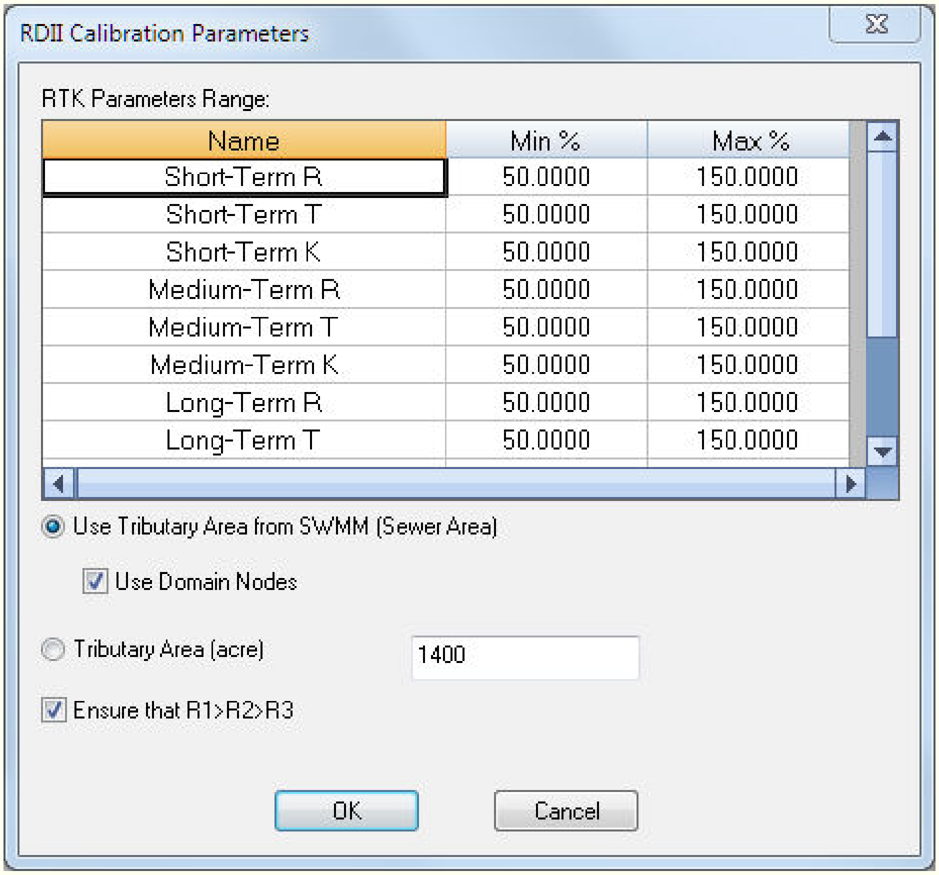
The calibration tool systematically searches for the best set of parameters that matches the RDII flow simulated by InfoSWMM

with RDII time series determined by the decomposition process. The parameter values would be searched within the minimum and the maximum ranges assigned by the user on dialog editor shown above. The model would adjust the nominal parameter values assigned by the user onInfoSWMM

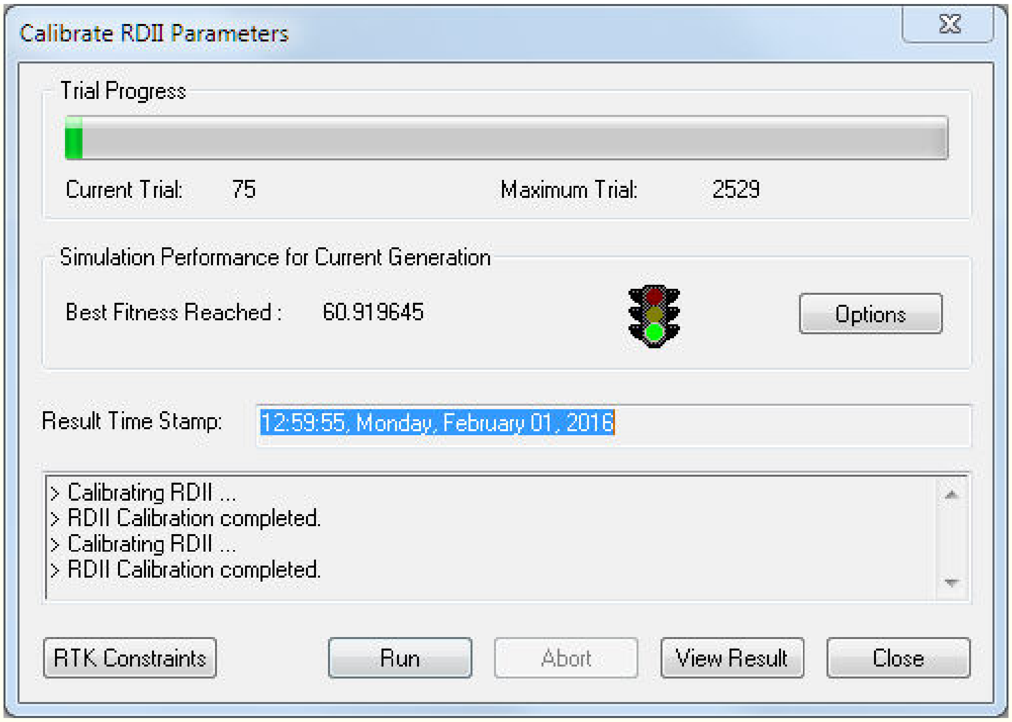
RDII hydrograph dialog editor (see below) by a randomly selected multiplier within the range assigned for the parameter and chooses the optimal set of adjustments. The *Tributary Area* may be taken from the sewershed area defined in InfoSWMM ’s

Hydrograph page, or the user can directly specify area of the tributary sewersheds. In addition, the user has the option to use sewershed area of the nodes defined in a domain. The *Ensure that R1>R2>R3*

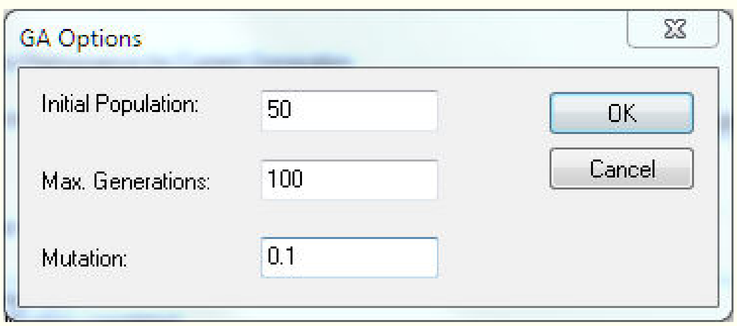
option ensures that the RDII flow contributed by the first triangle (fast flow contribution) would be higher than contribution of the second triangle (intermediate flow), and contribution of the second triangle would be higher than that of the third triangle (slow flow).



Domain Node option is checked, sewershed area of the nodes included in the domain will be considered. Nodes in the domain will not contribute sewershed area. Once the parameters are assigned, hitting the *OK* button would initiate the calibration dialog box (see below).



Options: Some Genetic Algorithms (GAs) parameters may be defined using the options page initiated by clicking the *Options* button on the *Calibrate RDII Parameters* dialog box.



Initial Population: Represents the number of initial solution candidates considered by the GAs calibrator.

Each solution candidate contains a value InfoSWMM

the assigned range for each RTK parameters. The higher the *Initial Population*, the better the calibration results would be. However, the calibration process takes more run time as the number of population increases.

Max. Generation: Represents the maximum number of iterations required to complete the calibration process. One generation represents running the model for *initial population* number of times, and each simulation represents different solution candidates.

The higher the maximum generation, the better the chance of improving the calibration. Again, the improvement comes at the cost of more calibration run time. The calibration process can stop before reaching the maximum generation if there is no improvement in results from generation to generation.

Mutation Rate: represents the percentage of solution candidates whose one or more parameter values needs to be randomly altered to inject new and potentially better solution candidates into the search process during each generation. The value must be within zero and one, and typical value is 0.1.

Calibration Results: Upon completing the calibration run, the best RTK parameter values would be reported as shown below. The percentage adjustment and then actual parameter values suggested are reported in the last two columns. In addition, graphical comparison of the RDII flow generated by the calibrated parameters and the RDII time series generated by the decomposition process would be provided to visually analyze the calibration results.

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2.8 Exporting Analysis Results

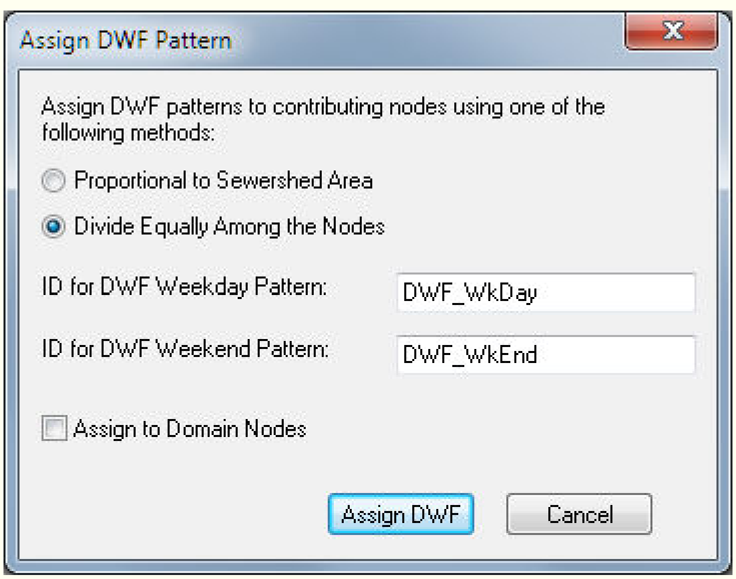
Some of the *RDII Analyst* results can be exported to text file or toInfoSWMM

and can be used to model the collection system. The export tools are available from the *Export* menu. *Save Meter Data*: This saves the corrected flow monitoring data to text file for later use.

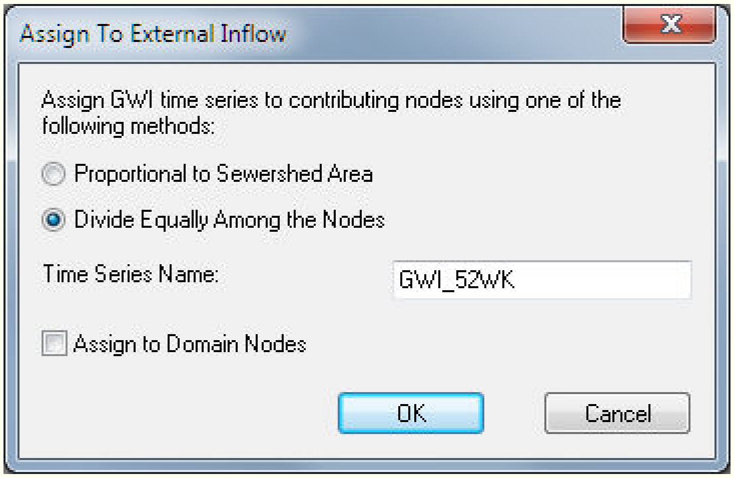
Save Raingage Data: This function saves corrected rainfall data to text file for later use. *Export DWF Pattern*: This function exports hourly DWF patterns for weekday and weekend to a text file.

Assign DWF Pattern: This tool assigns the hourly DWF patterns developed for weekdays and weekends to InfoSWMM

nodes that contribute flow to the monitoring site. The DWF pattern is allocated to the contributing nodes either *proportional to sewershed area* of each contributing node, or simply *equally among all contributing nodes*. The assignment could be limited to nodes in a domain by checking the *Assign to Domain Nodes* option.



Assign GWI Time Series: This function assigns the groundwater flow time series toInfoSWMM nodes that contribute flow to the monitoring site. The time series is assigned to the nodes as external inflow. The GWF time series is allocated to the contributing nodes either *proportional to sewershed area* of each contributing node, or simply *equally among all contributing nodes*. The assignment could be limited to nodes in a domain by checking the *Assign to Domain Nodes* option.



Assign RDII: This function assigns either the RTK parameters determined by the calibration tool or the RDII time series determined by decomposing the flow monitoring data toInfoSWMM

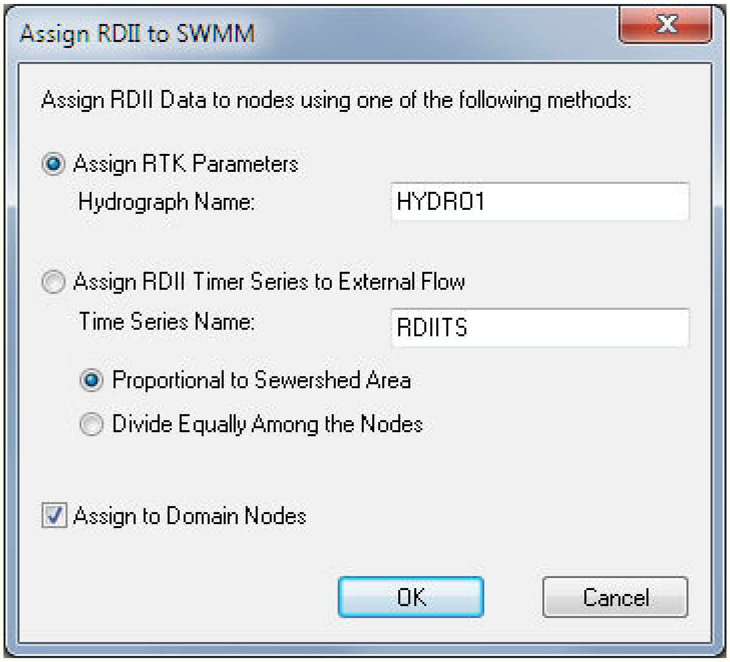
nodes that contribute flow to the monitoring site. The RTK parameters would be exported to InfoSWMM

and are assigned to RDII hydrographs for each contributing node.

The time series is assigned to the nodes as external inflow. The RDII time series is allocated to the contributing nodes either *proportional to sewershed area* of each contributing node, or simply *equally among all contributing nodes*. The assignment could be limited to nodes in a domain by checking the *Assign to Domain Nodes* option. Please note that if both the GWF time series and the RDII time series are exported into InfoSWMM

, only the time series exported last would be available for use. InfoSWMM

takes only one external inflow time series at a time.



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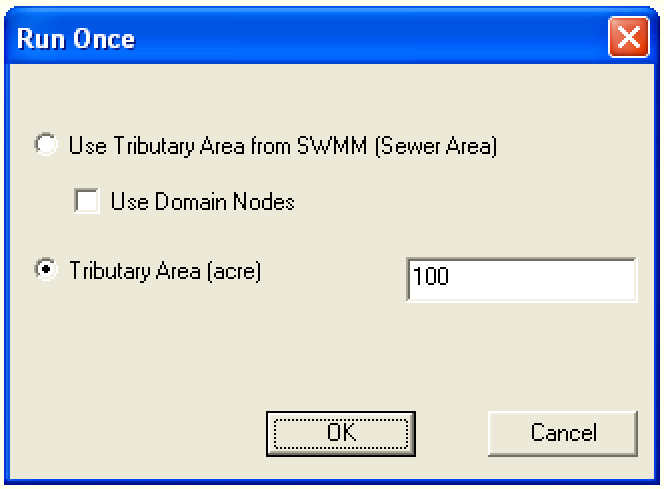
2.9 Fine Tuning the Calibration Manually

RTK parameters generated by the GA RDII calibration process can be further adjusted manually and checked for calibration by using the Run Once command. After exporting the GA generated RTK values to the RDII Hydrograph (**Export > Export RDII**), open the RDII Hydrograph (**Analysis > Hydrograph**). Adjust the RTK parameters according to your local knowledge and engineering judgment. Now click the Run Once command () from the toolbar.



Adjust the parameters as necessary. Click **OK** and the calibration results are shown in the Calibration Report and Calibration Graph (see Section 2.6 above).

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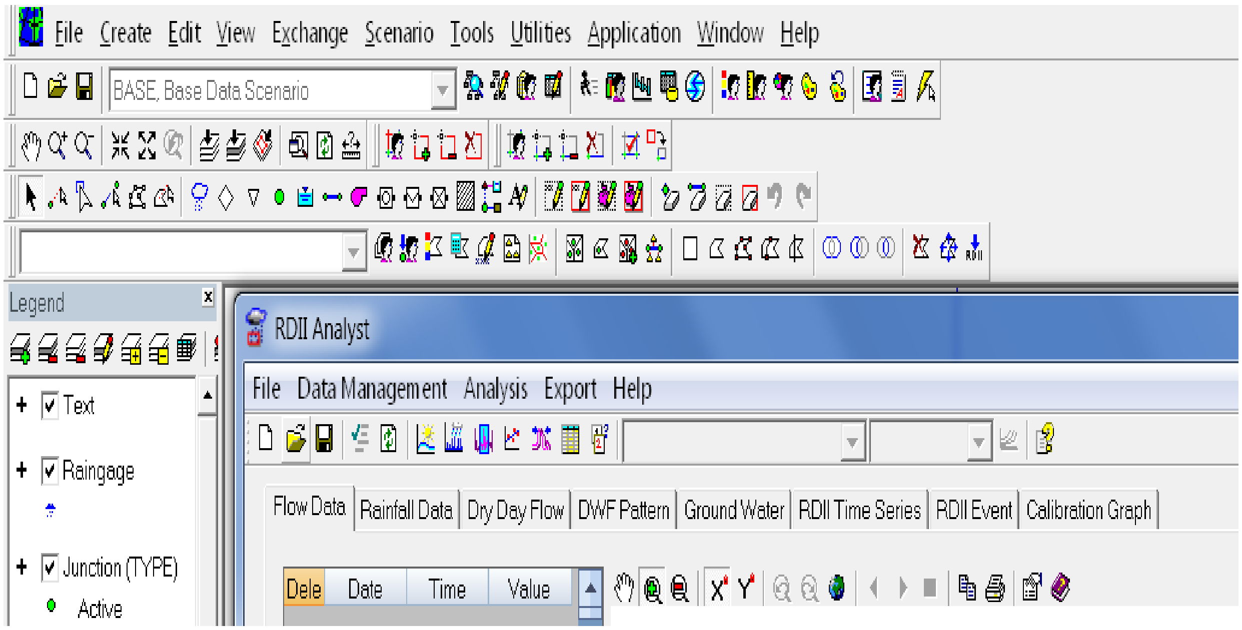
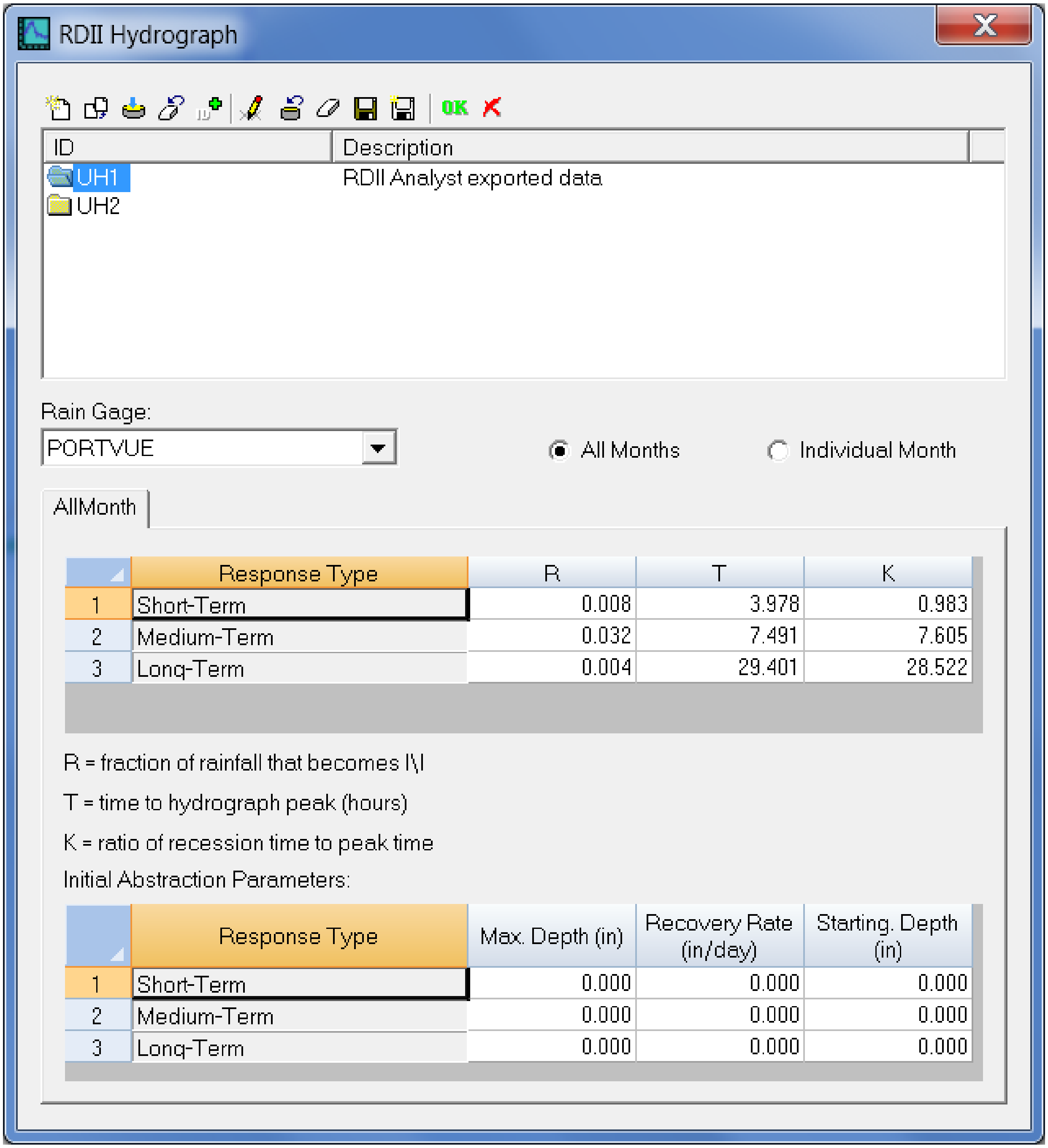
Steps for Running RDII Analyst in H2OMap SWMM

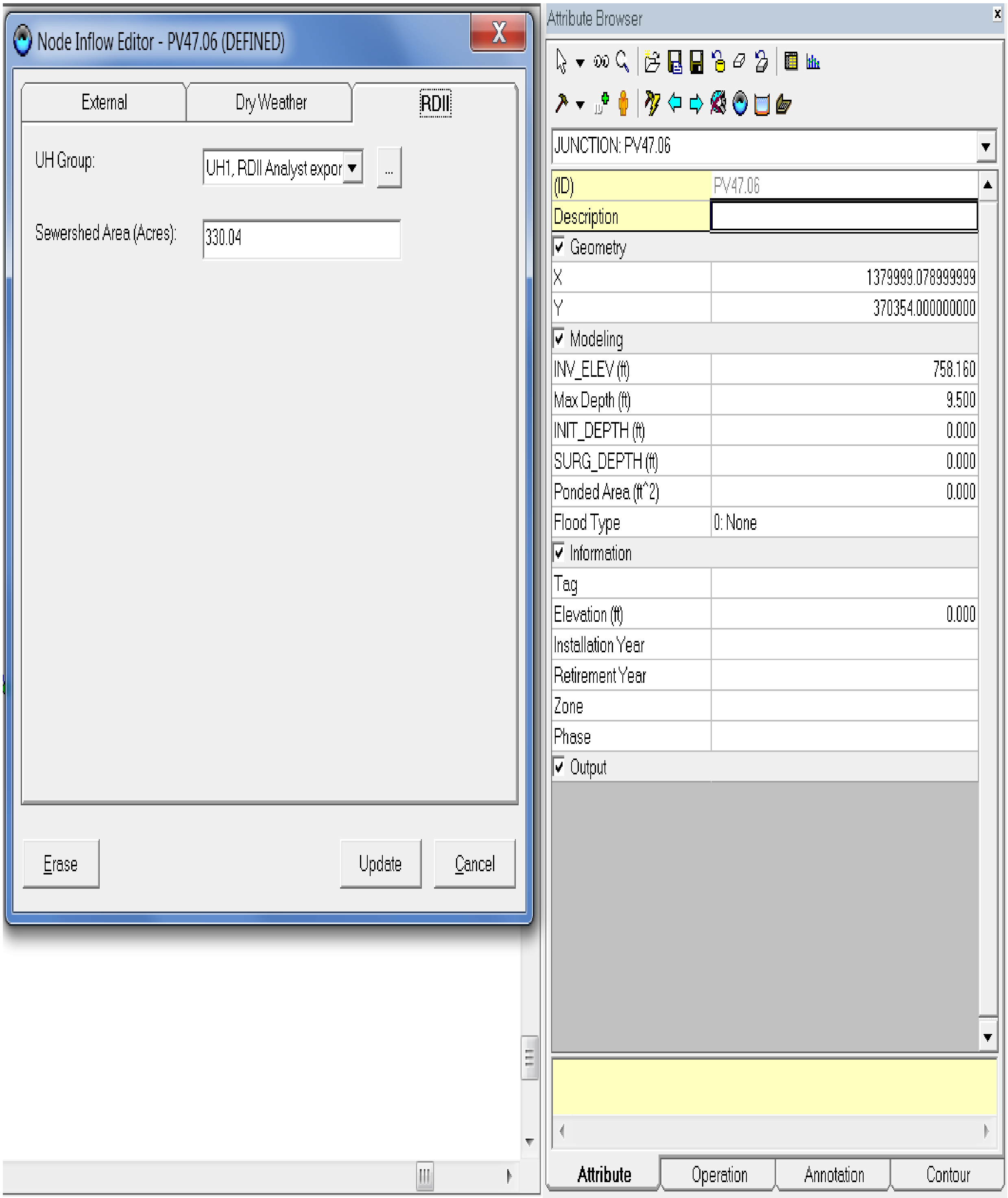
Steps for Running RDII Analyst in H2OMap SWMM



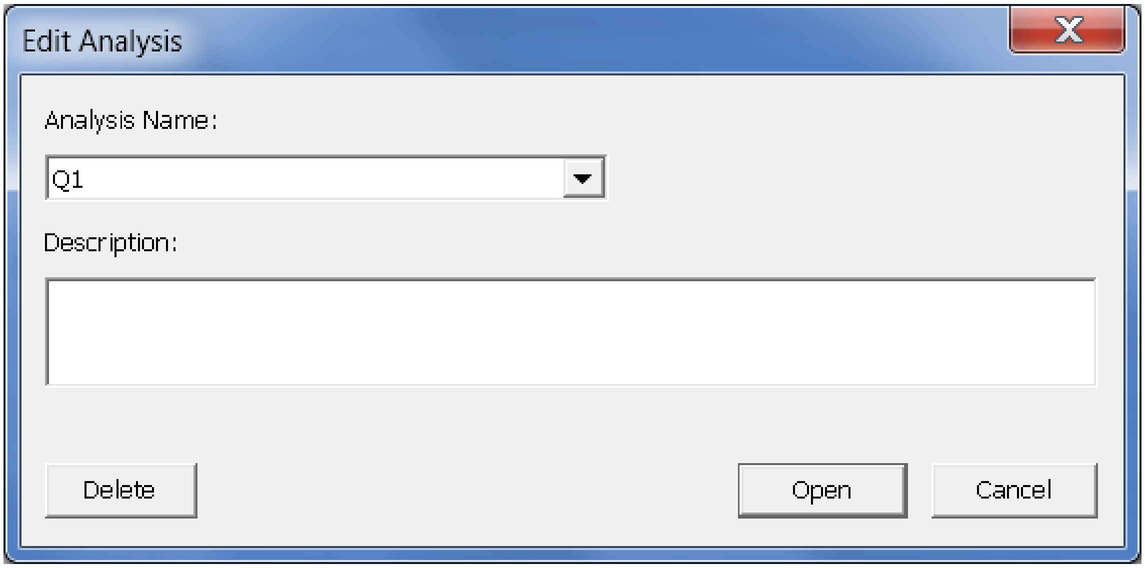
Step 1. Create the RTK UH in the H2OMap SWMM Attribute Browser (AB)



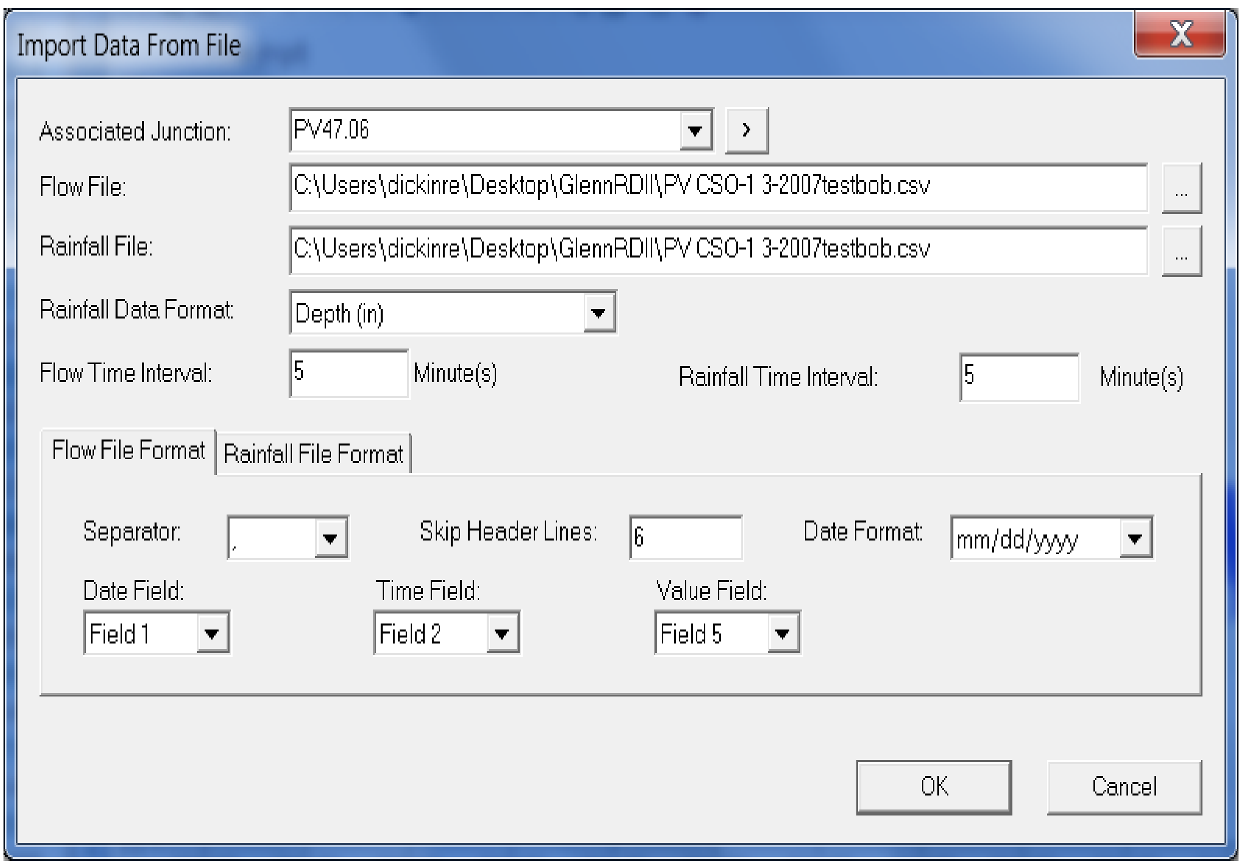
Step 2. Assign the RTK UH to a node (you need one node at least to Run RDII Analyst).



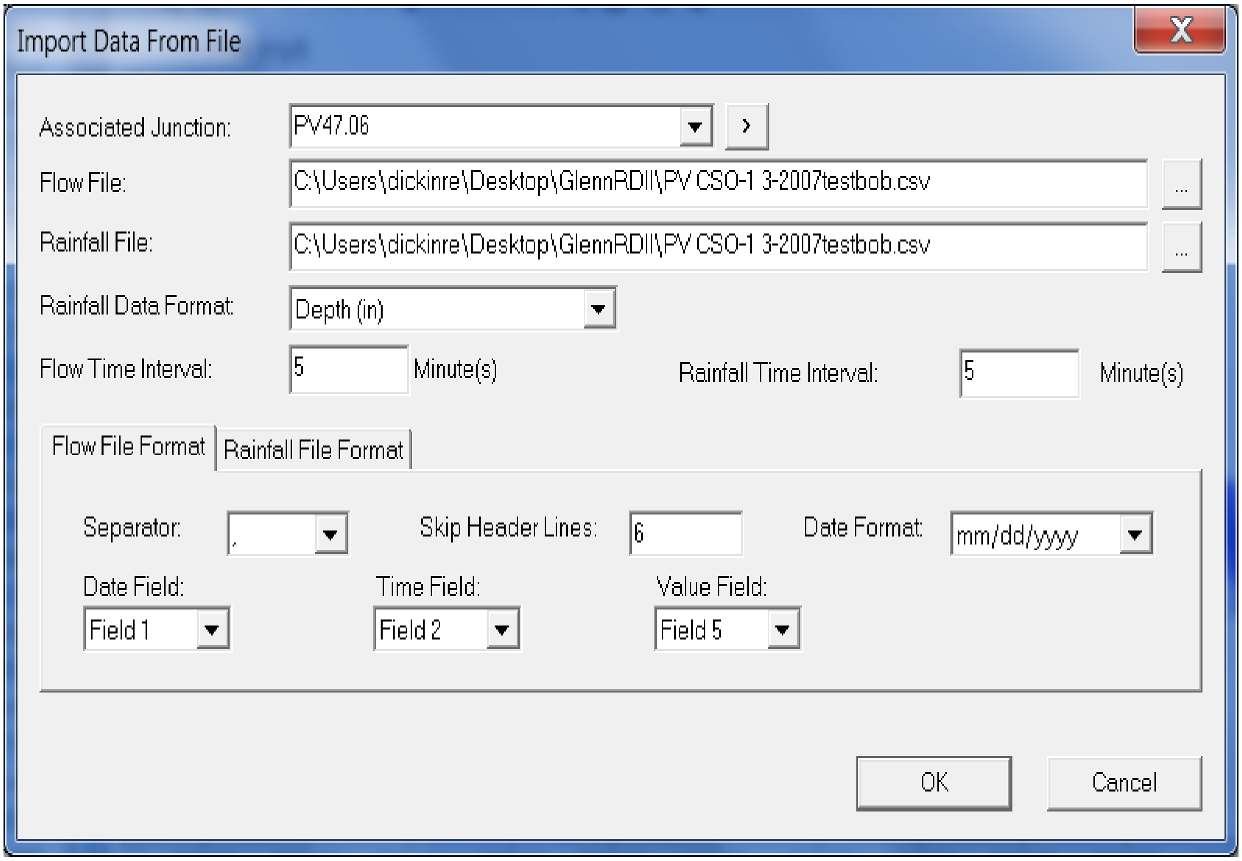
Step 3. Open up RDII Analyst and Set up the Node for the Analysis



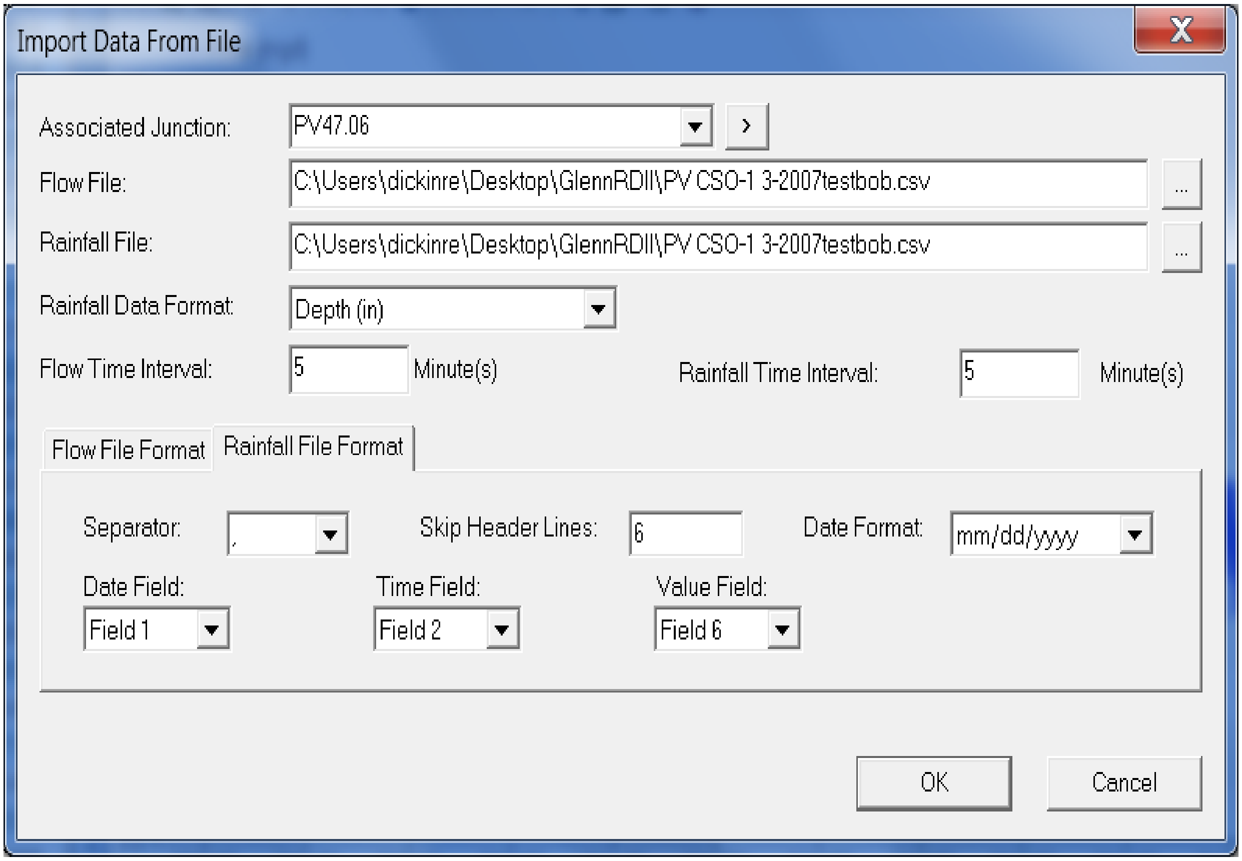
Step 4. Select a Node



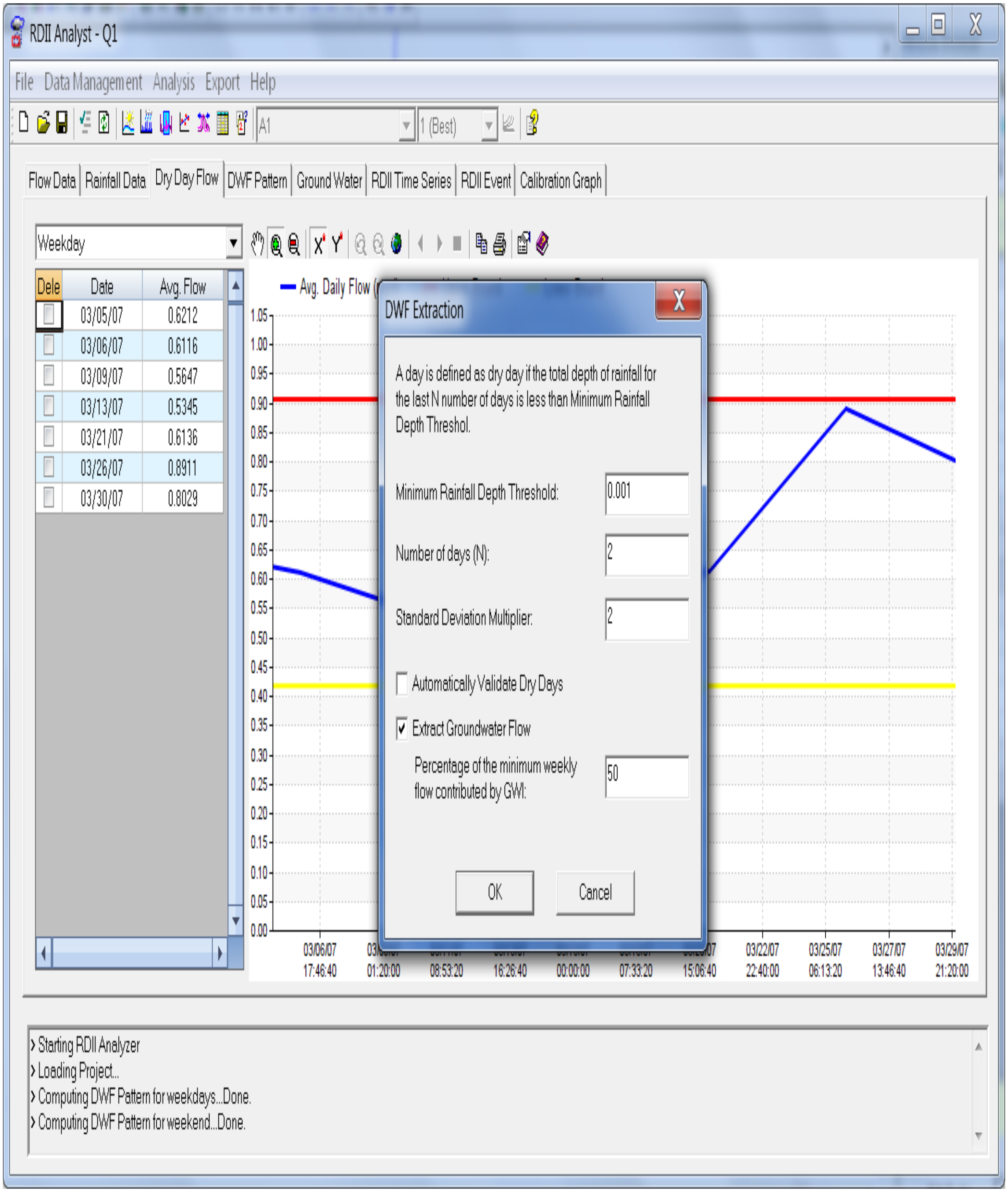
Step 5. Define the Flow Data



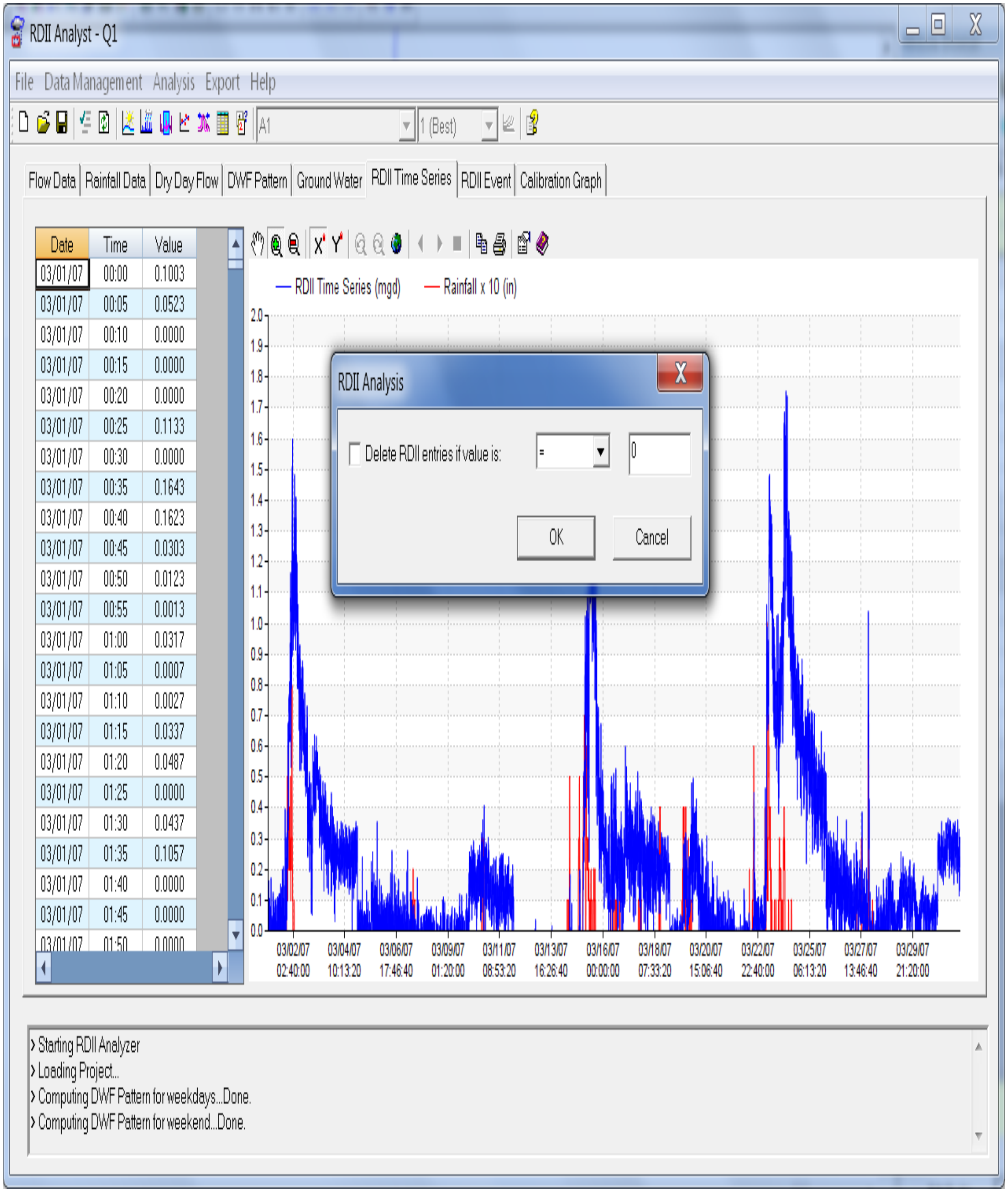
Step 6. Define the Rainfall Data



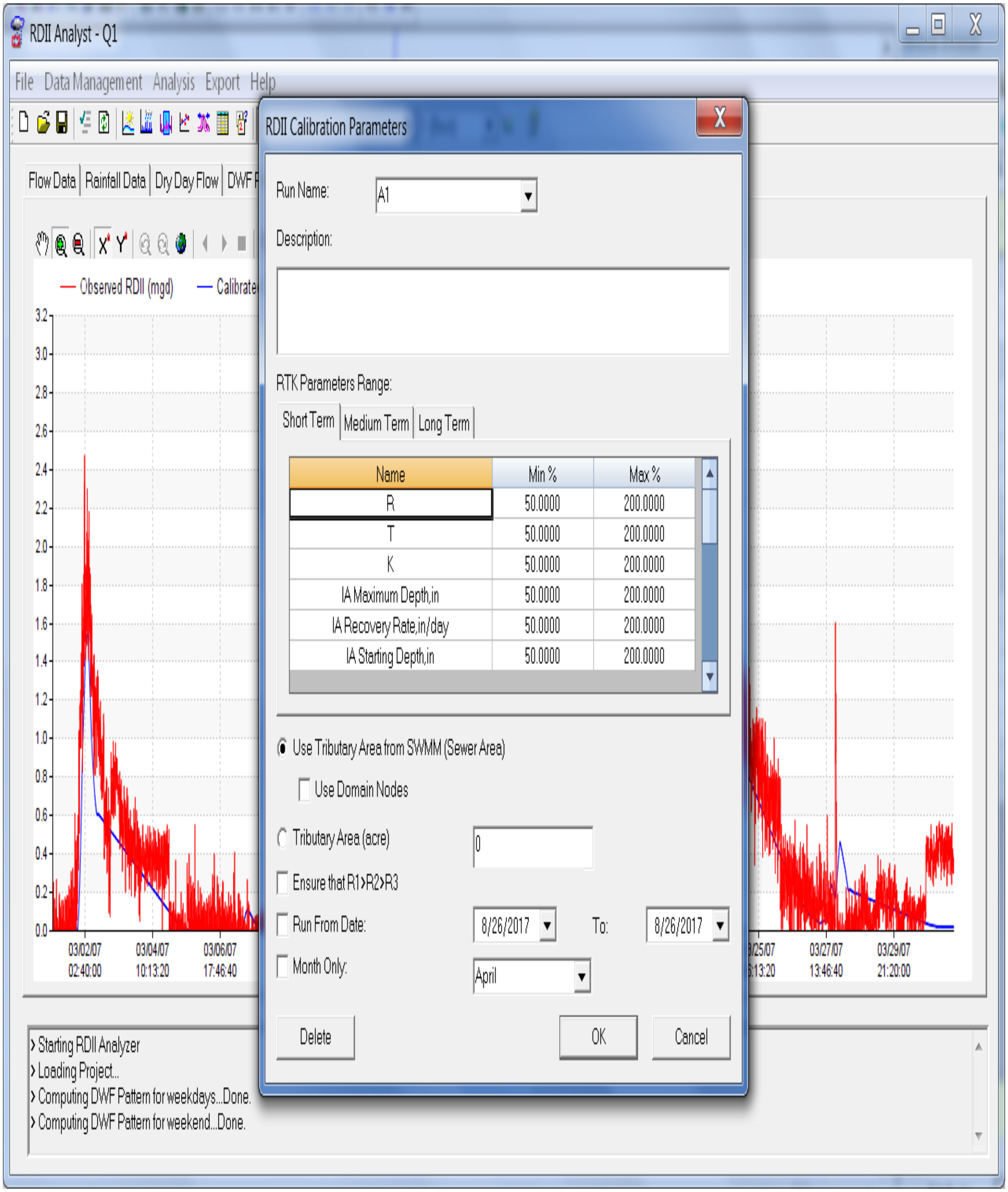
Step 7. Calculate the DWF and GW flow



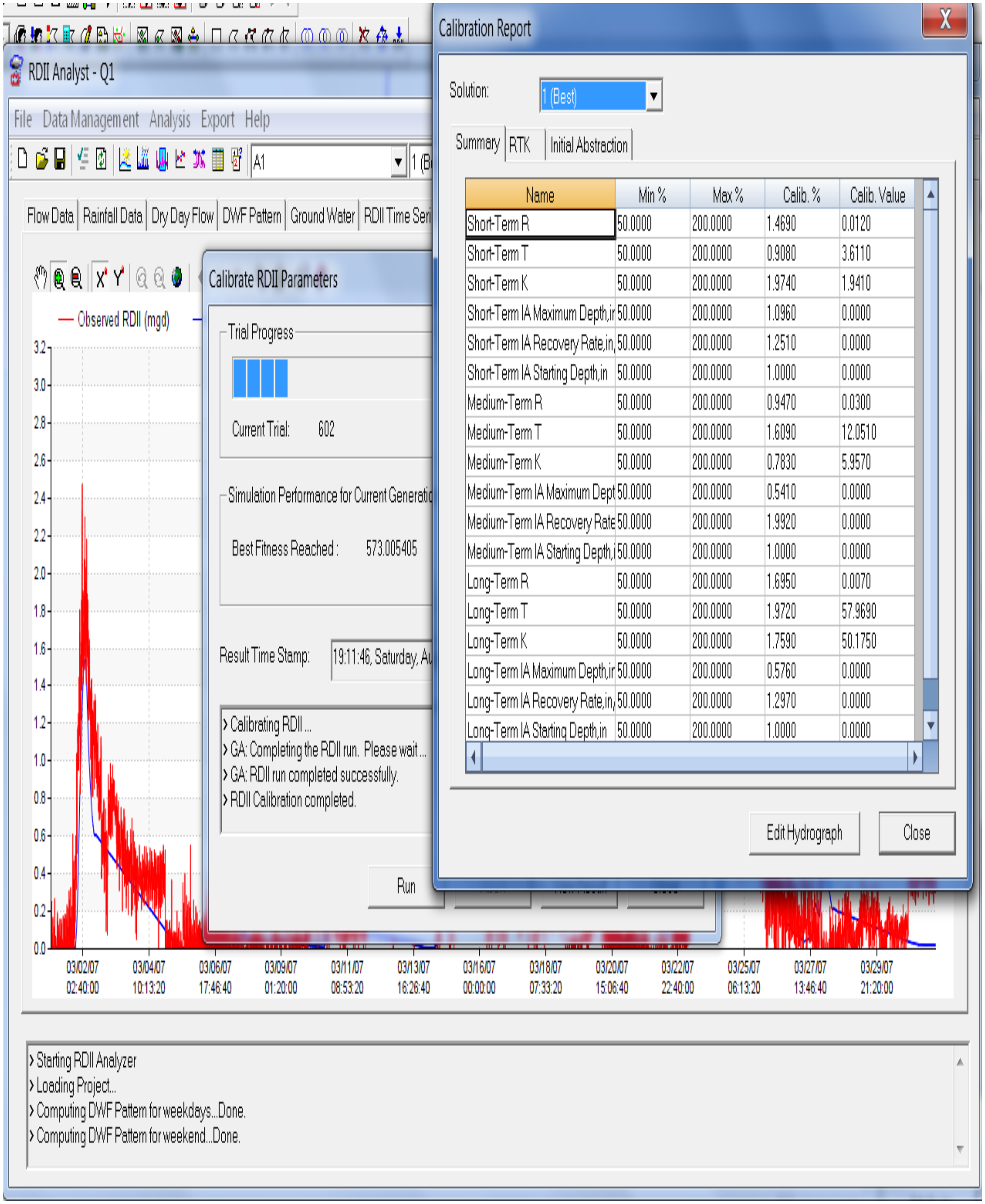
Step 8. Calculate the Wet Weather flow – Flow minus Dry Weather Flow



Step 9. Set up the RDII GA Run

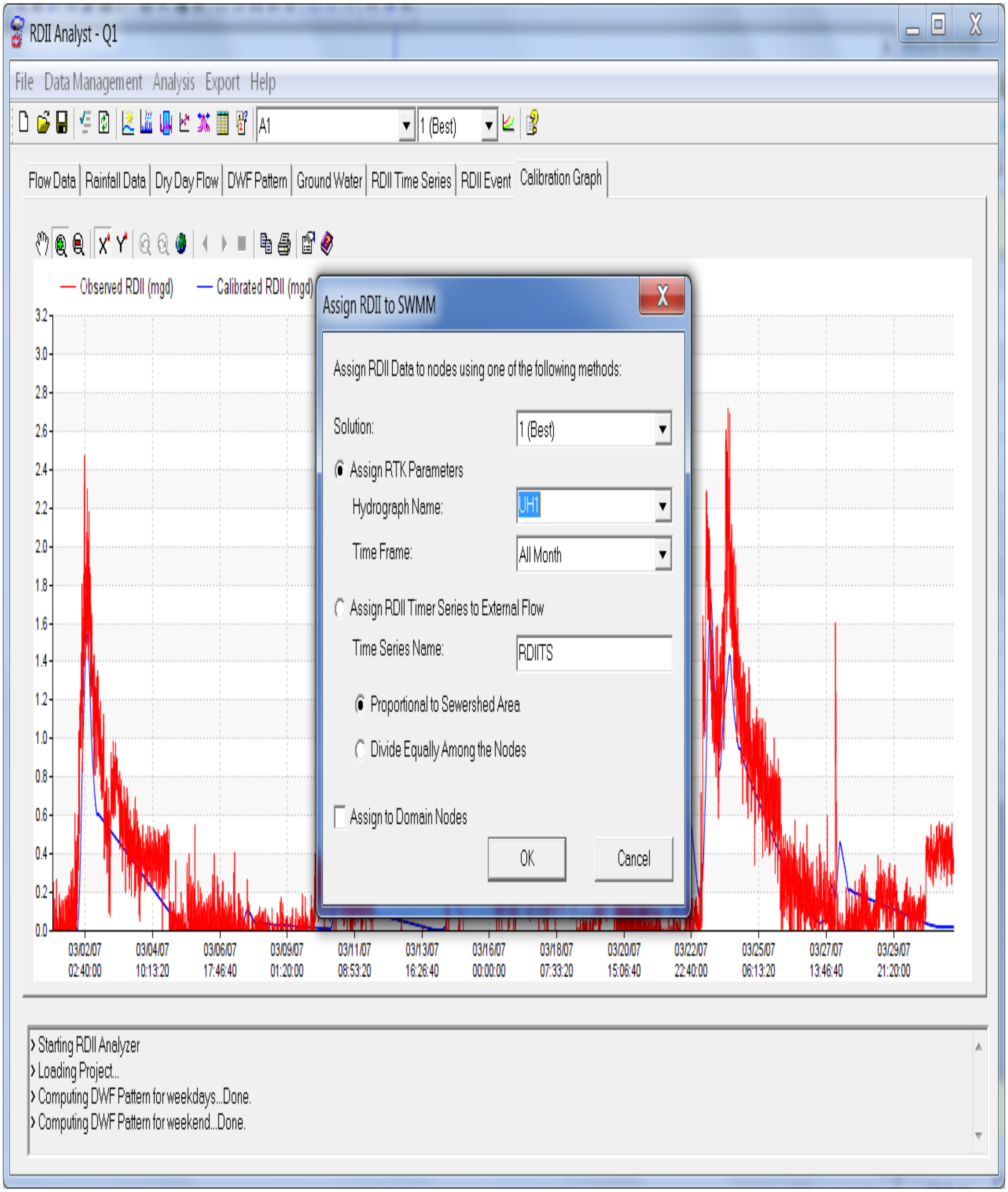


Step 10. The RDII Calibration Result



Name	Min %	Max %	Calib. %	Calib. Value
Short-Term R	50.0000	200.0000	1.4690	0.0120
Short-Term T	50.0000	200.0000	0.9080	3.6110
Short-Term K	50.0000	200.0000	1.9740	1.9410
Short-Term IA Maximum Depth,ir	50.0000	200.0000	1.0960	0.0000
Short-Term IA Recovery Rate,in	50.0000	200.0000	1.2510	0.0000
Short-Term IA Starting Depth,in	50.0000	200.0000	1.0000	0.0000
Medium-Term R	50.0000	200.0000	0.9470	0.0300
Medium-Term T	50.0000	200.0000	1.6090	12.0510
Medium-Term K	50.0000	200.0000	0.7830	5.9570
Medium-Term IA Maximum Dept	50.0000	200.0000	0.5410	0.0000
Medium-Term IA Recovery Rate	50.0000	200.0000	1.9920	0.0000
Medium-Term IA Starting Depth,i	50.0000	200.0000	1.0000	0.0000
Long-Term R	50.0000	200.0000	1.6950	0.0070
Long-Term T	50.0000	200.0000	1.9720	57.9690
Long-Term K	50.0000	200.0000	1.7590	50.1750
Long-Term IA Maximum Depth,ir	50.0000	200.0000	0.5760	0.0000
Long-Term IA Recovery Rate,in	50.0000	200.0000	1.2970	0.0000
Long-Term IA Starting Depth,in	50.0000	200.0000	1.0000	0.0000

Step 11. Export RTK parameters back to H2Omap SWMM


RDII Analyst - Q1
File Data Management Analysis Export Help
A1
1 (Best)
Flow Data Rainfall Data Dry Day Flow DWF Pattern Ground Water RDII Time Series RDII Event Calibration Graph
Observed RDII (mgd)
Calibrated RDII (mgd)
Assign RDII to SWMM
Assign RDII Data to nodes using one of the following methods:
Solution:
1 (Best)
Assign RTK Parameters
Hydrograph Name:
UH1
Time Frame:
All Month
Assign RDII Timer Series to External Flow
Time Series Name:
RDIITS
Proportional to Sewershed Area
Divide Equally Among the Nodes
Assign to Domain Nodes
OK
Cancel
> Starting RDII Analyzer
> Loading Project...
> Computing DWF Pattern for weekdays...Done.
> Computing DWF Pattern for weekend...Done.

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Step 1. Open the Sample RDII Analyst Project

All of the @innovzye sample files are in the Public Documents/ Name of Software / Examples folder

The file and directory you need are

InfoSWMM (InfoSWMM file end in MXD

and are Arc Map files)C:\Users\Public\Documents\InfoSWMM\Examples SampleRDIIANALYST.mxd

InfoSWMM (InfoSWMM file end in MXD

and are Arc Map files)

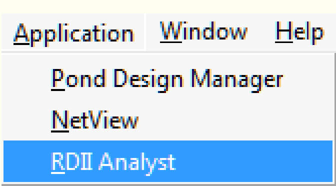
MXD Files are (When a map is saved

a new file extension is created (.mxd). This file does not save the layers or spatial data with it, only the relative pathnames. What this means is if the data used in the map is not in the same location as the previous time it was opened there will be an error. This assists with keeping the file small and reduces the amount of redundancy in data management.) 1. In

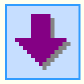
the *ARCMAP* window, select *AN EXISTING MAP* option in the *START USING ARCMAP WITH* area and then click OK. If the *ARCMAP* window is not shown, simply choose *OPEN* command from the *FILE* menu. On the *OPEN* dialog box, navigate to the directory containing the "**SampleRDIIANALYST**" project and choose that file.

2. C:\Users\Public\Documents\InfoSWMM\Examples**SampleRDIIANALYST**.MXD

(may be different for custom installations)



3. Go

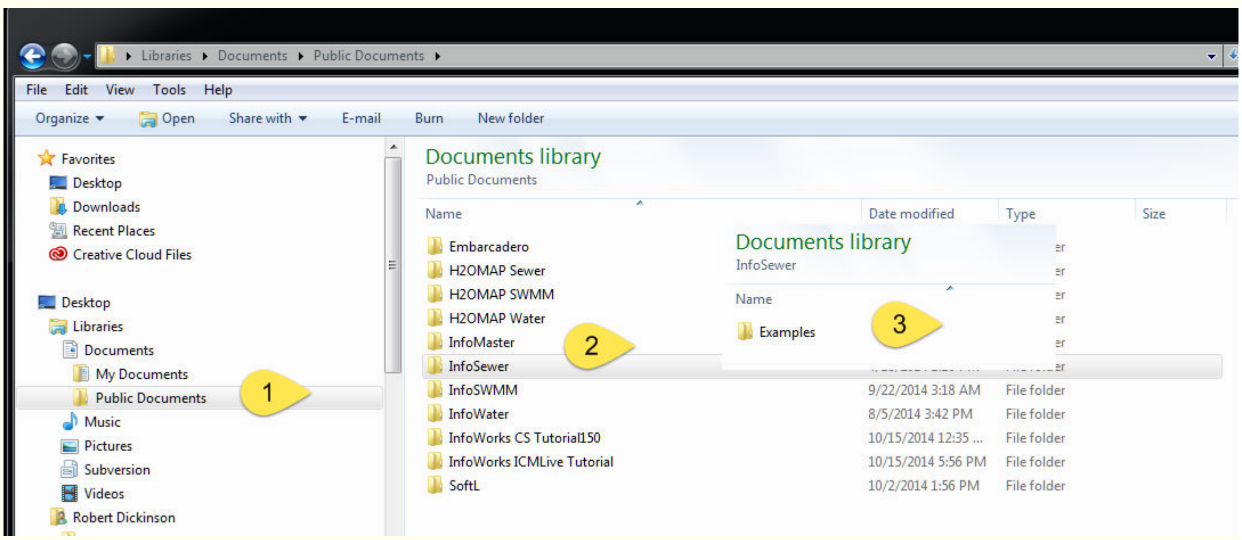
to the *TOOLS* menu, choose *EXTENSIONS*, and click on the InfoSWMM checkbox and then click on *CLOSE* button. Click on the *PURPLE DOWN ARROW* icon () to initialize InfoSWMM.

When initialized, the icons on the InfoSWMM toolbars will be enabled for use.

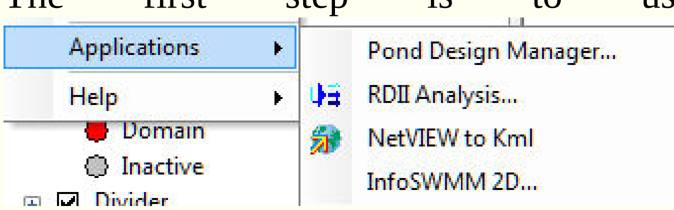
4. Before

continuing, save the "**SampleRDIIANALYST**" project to a new project name. If you wish to restart the tutorial, the original project will be available. Choose the *SAVE AS* command from the *FILE* menu.

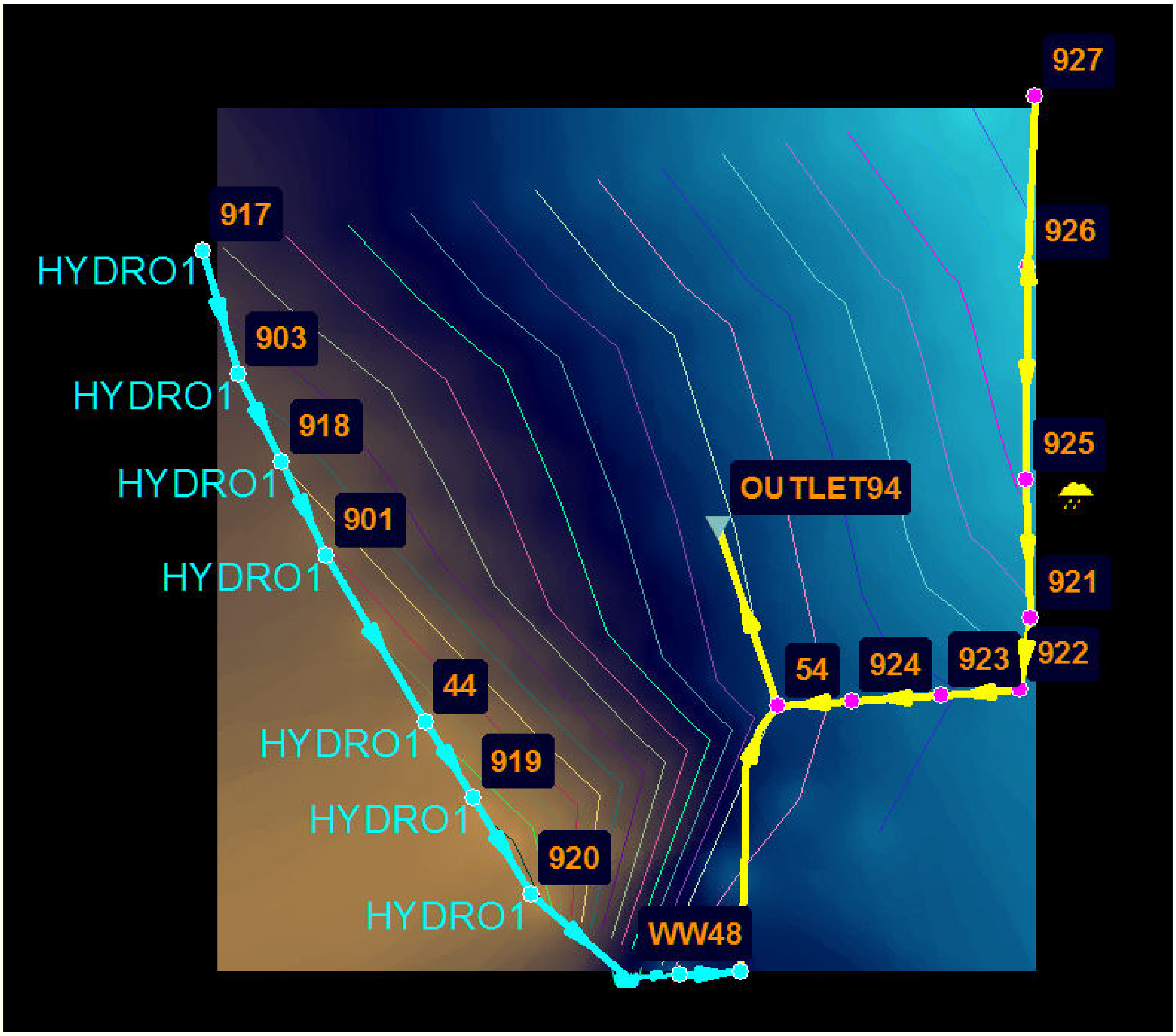
On the dialog box, enter the new project name "Tutorial". This becomes the active project.



The first step is to use the Menu command



to open up RDII Analyst. The following is the InfoSWMM network in inverse colors.



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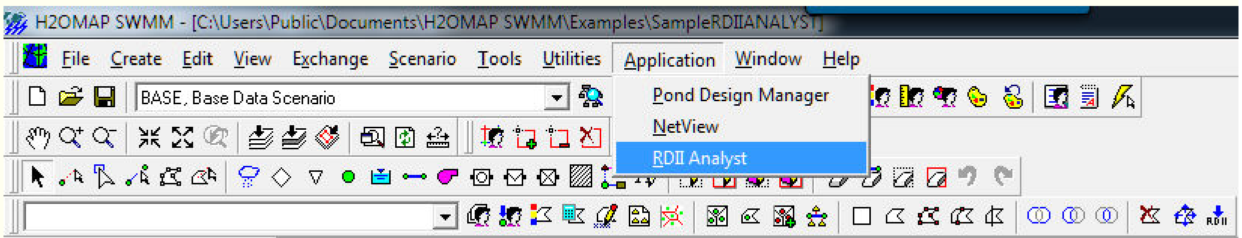
Step 2. Initialize RDII Analyst

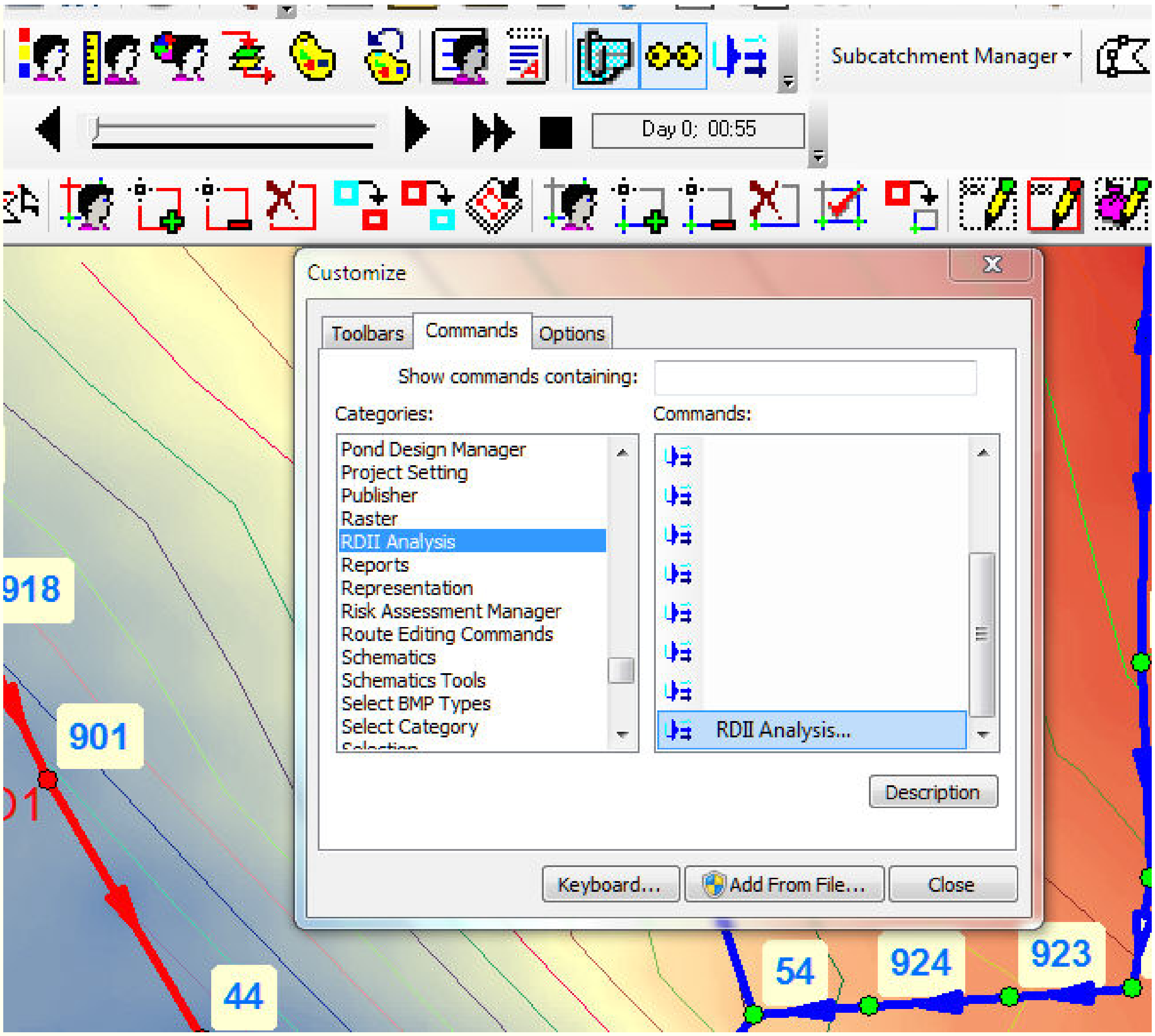
1. Initialize

RDII Analyst by selecting RDII Analysis from theInfoSWMM

Applications menu:



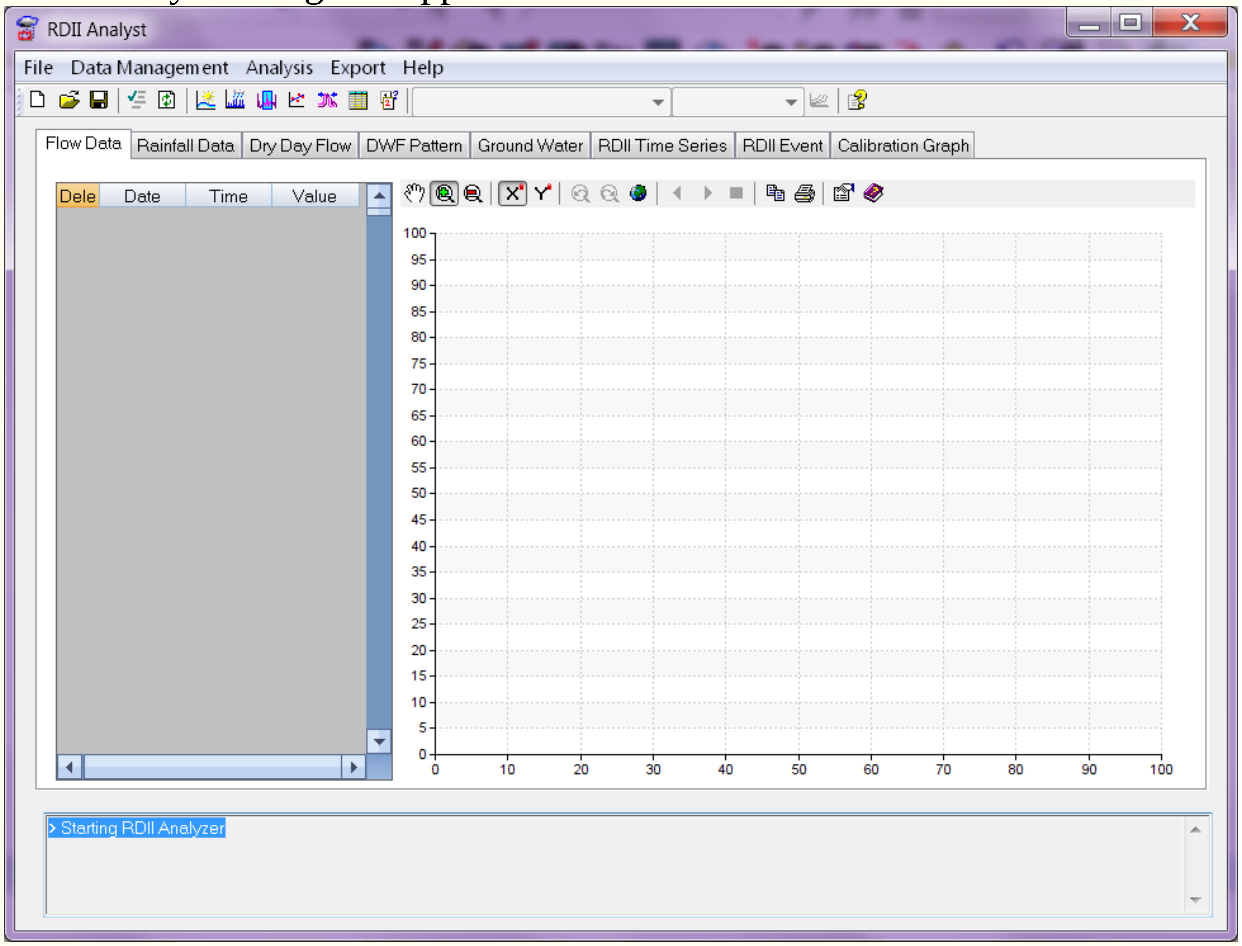
2. You can also make a custom Icon for RDII Analyst using the Customize Menu command of Arc Map (InfoSWMM Only) and then use that Icon to open RDII Analyst.



Subcatchment Manager
Day 0; 00:55
Customize
Toolbars
Commands
Options
Show commands containing:
Categories:
Commands:
Pond Design Manager
Project Setting
Publisher
Raster
RDII Analysis
Reports
Representation
Risk Assessment Manager
Route Editing Commands
Schematics
Schematics Tools
Select BMP Types
Select Category
RDII Analysis...
Description
Keyboard...
Add From File...
Close
918
901
44
54
924
923

3. The

RDII Analyst dialog box appears:



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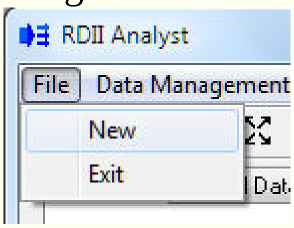
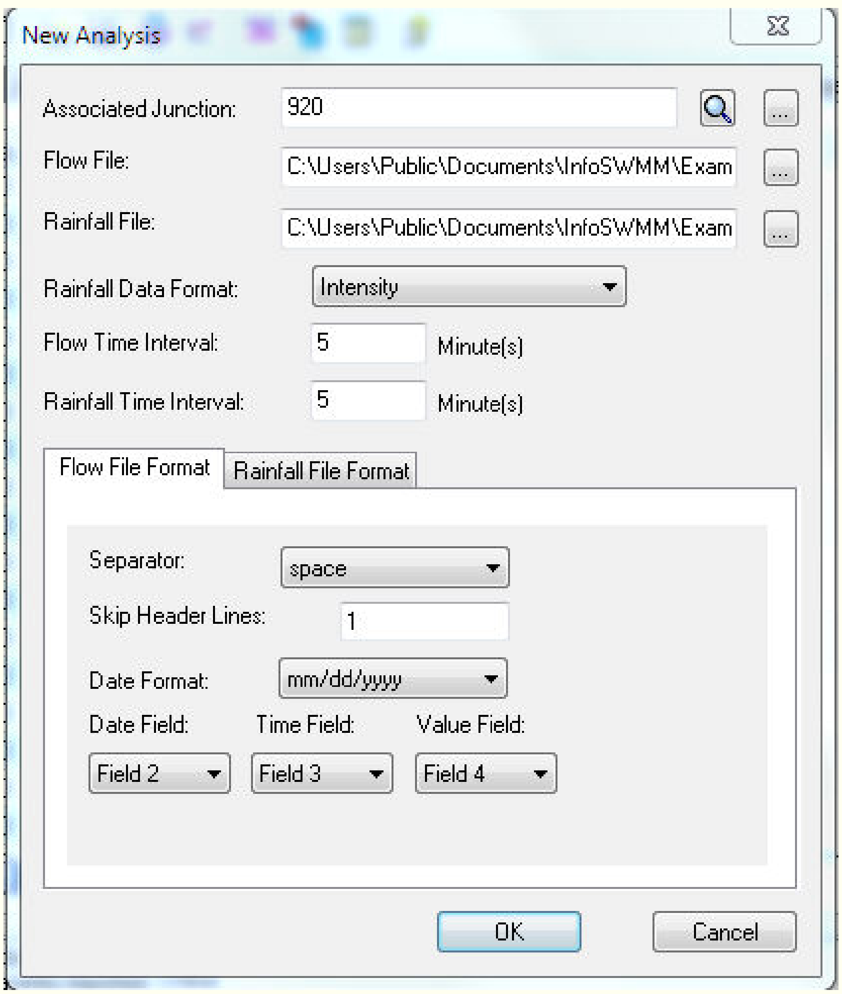
Step 3. Specify Flow Monitoring Data and Rainfall Data

1. Create

a new analysis by clicking the New button () from the toolbar or the New Menu command 

Doing this will launch the New Analysis dialog editor:



FIle links for Rainfall and Flow

C:\Users\Public\Documents\InfoSWMM\Examples\FlowData.TXT

C:\Users\Public\Documents\InfoSWMM\Examples\RainfallData.txt The top of the Flow Data File looks like

SITE DATE HOUR

FLOW (cfs)

------ ---------- ---- ----------

MS0350 03/30/1995 23 1.815

MS0350 03/31/1995 0 1.624

The top of the Rain Data File looks like

Year Month Date hour MIN WS1218 WS1209 WS1207 WS1202 WS1206 WS1204 WS1203

WS1216 WS1202

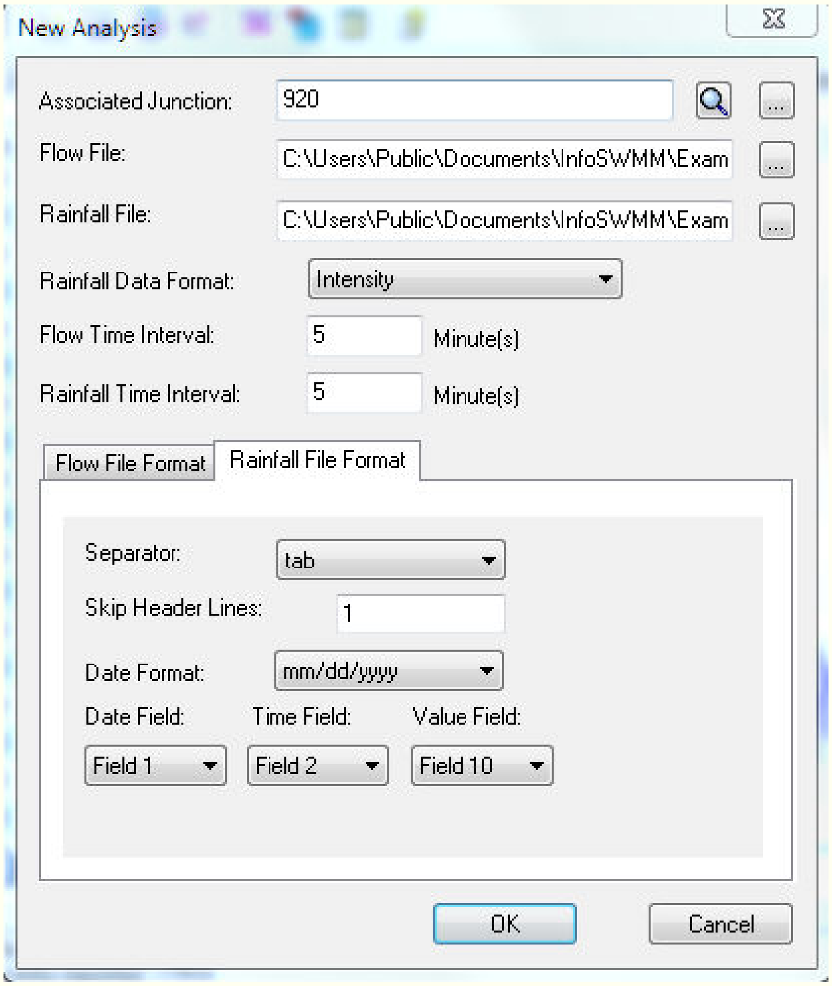
3/31/1995 23:0 1995 3 31 23 0 0 0 0 0 0 0 0 0 0 0

3/31/1995 23:5 1995 3 31 23 5 0 0 0 0 0 0 0 0 0 0

2. On

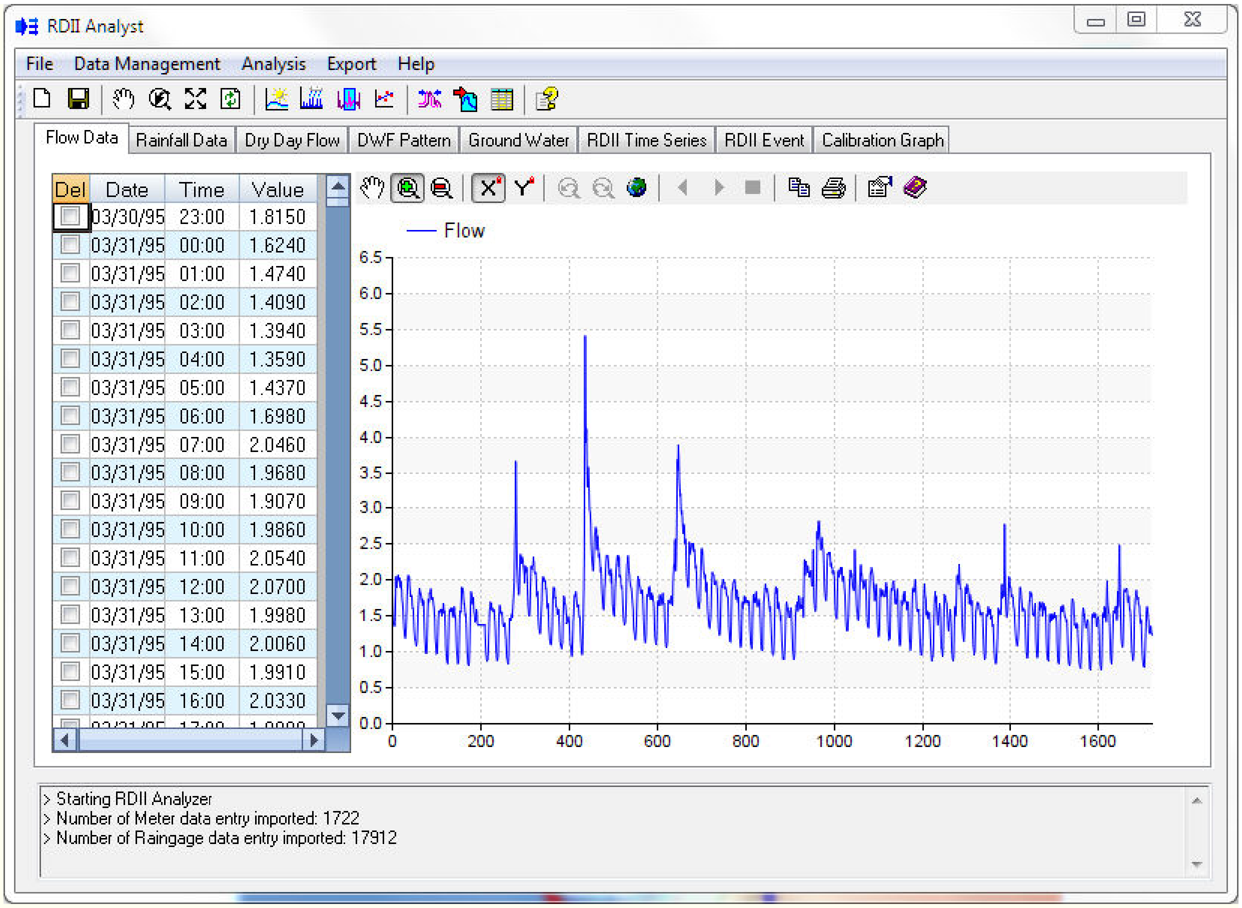
the initiated dialog, specify file names for the flow monitoring data and the rainfall data as shown above. The files are available at C:\Users\Public\Documents\InfoSWMM\Examples\ 3. Specify

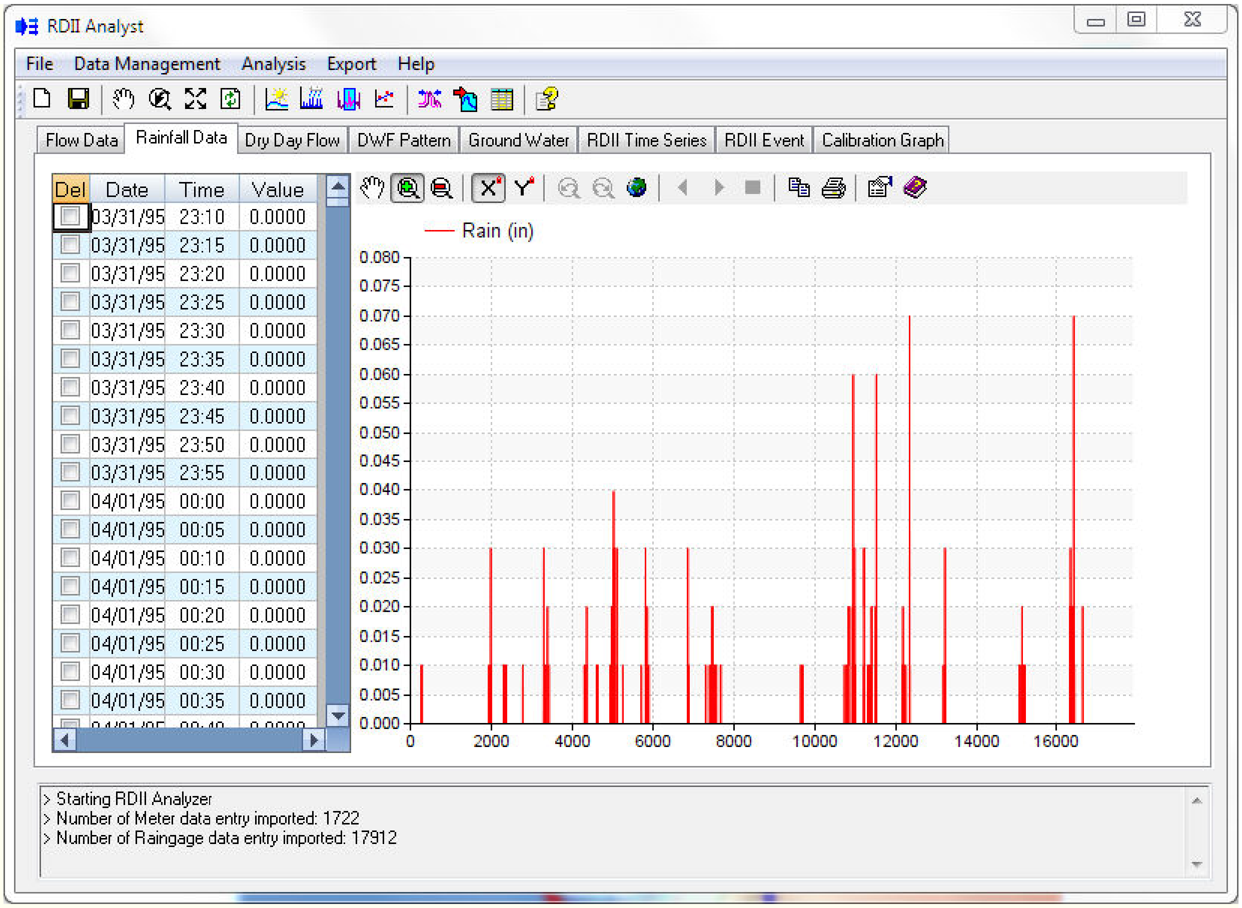
all other input information regarding the monitoring site, and format of the flow data (shown above) and the rainfall data (shown below). *Note: If you have previously successfully imported the data then a profile for the Associated Junction will be created. Clicking the Search button () will search for the parameters used on the previous successful import and automatically populate the parameter fields if the profile is found.*



4. Click

OK and review the data both graphically and in report form.


RDII Analyst
File Data Management Analysis Export Help
Flow Data
Rainfall Data
Dry Day Flow
DWF Pattern
Ground Water
RDII Time Series
RDII Event
Calibration Graph
Del Date Time Value
03/30/95 23:00 1.8150
03/31/95 00:00 1.6240
03/31/95 01:00 1.4740
03/31/95 02:00 1.4090
03/31/95 03:00 1.3940
03/31/95 04:00 1.3590
03/31/95 05:00 1.4370
03/31/95 06:00 1.6980
03/31/95 07:00 2.0460
03/31/95 08:00 1.9680
03/31/95 09:00 1.9070
03/31/95 10:00 1.9860
03/31/95 11:00 2.0540
03/31/95 12:00 2.0700
03/31/95 13:00 1.9980
03/31/95 14:00 2.0060
03/31/95 15:00 1.9910
03/31/95 16:00 2.0330
Flow
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
200
400
600
800
1000
1200
1400
1600
> Starting RDII Analyzer
> Number of Meter data entry imported: 1722
> Number of Raingage data entry imported: 17912



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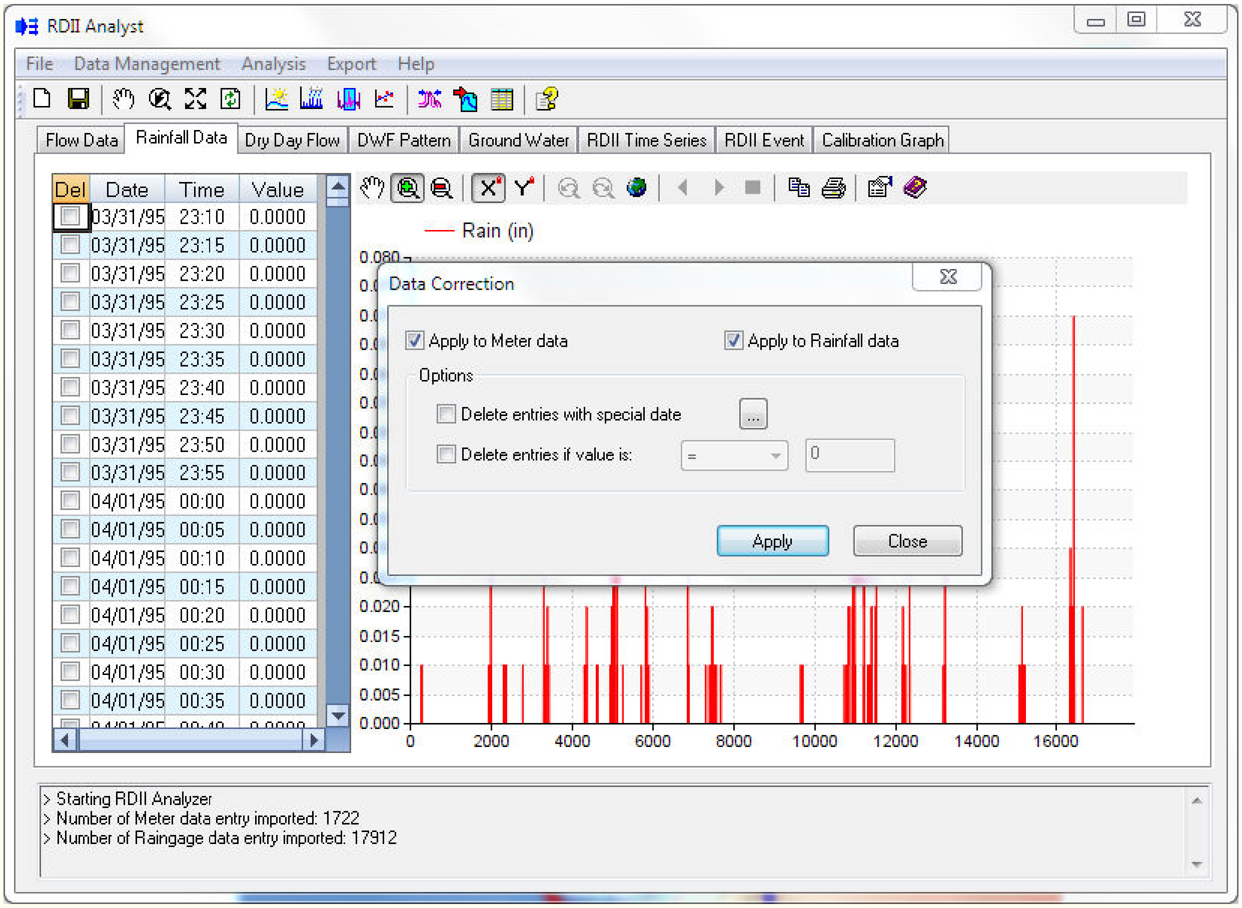
Step 4. QA/QC of the Flow Monitoring and Rainfall Data

RDII Analyst allows you to edit the flow data and the rainfall data. You can delete or change some of the suspicious data that are outliers. You can also remove data for non-representative days such as holidays from the analysis. You can manually edit data from the *Value*

column of the desired row(s) and save the changes using the Save () tool on the toolbar. In this tutorial, you will remove data values corresponding to a New Year day (i.e., 01/01/1995) and Independence Day (i.e., 07/04/1995).

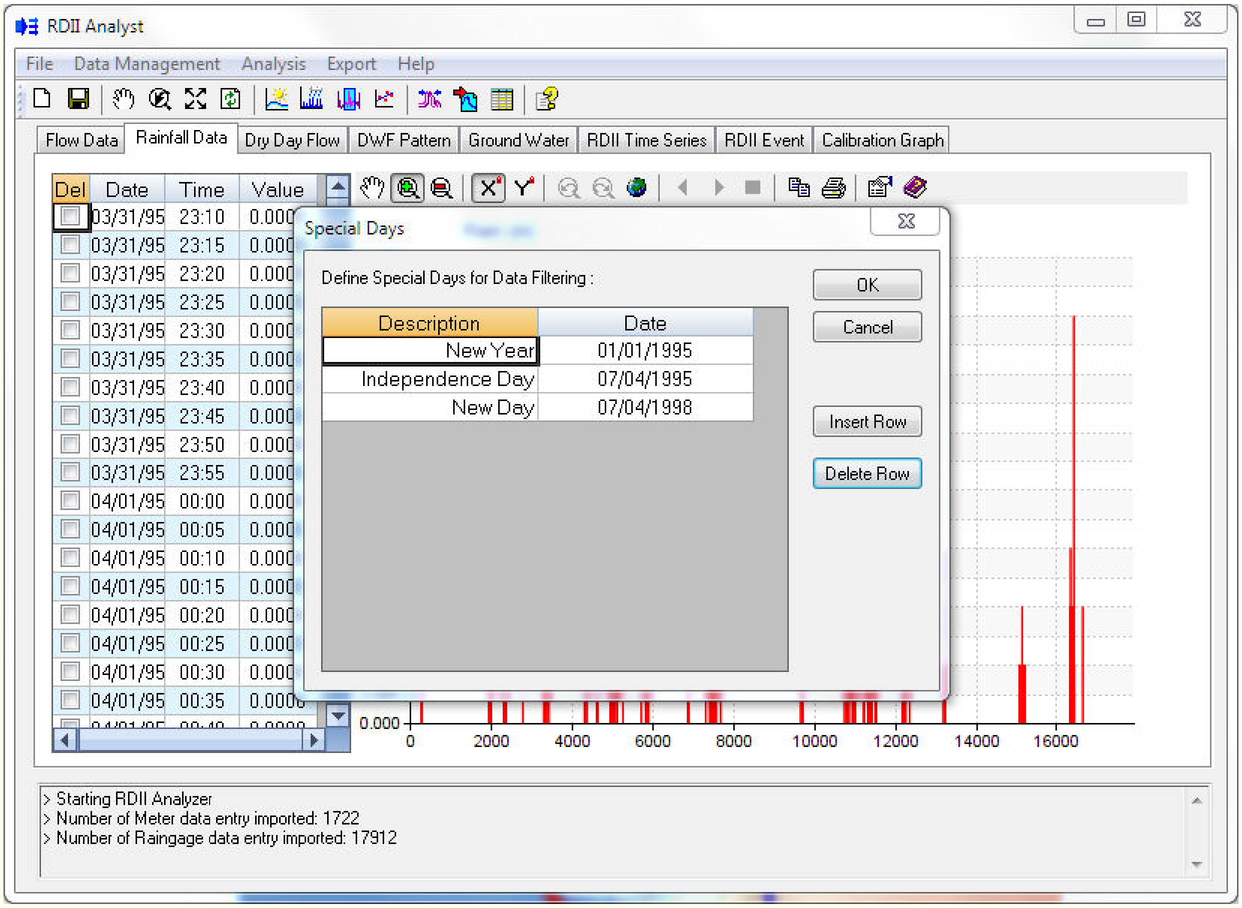
1. From

the menu, click *Data Management* -> *Data Correction*. On the initiated *Data Correction* editor, select the options as shown below.



2. Click

the Browse button (...) to open a list of Special Days to remove from the data. New days can be copied and pasted from Windows Clipboard.



3. Click

OK. Then click Apply

to remove the flow data corresponding to the listed holidays.

4. Review

the results to verify that the flow monitoring data for the two days are removed from the list.

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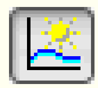
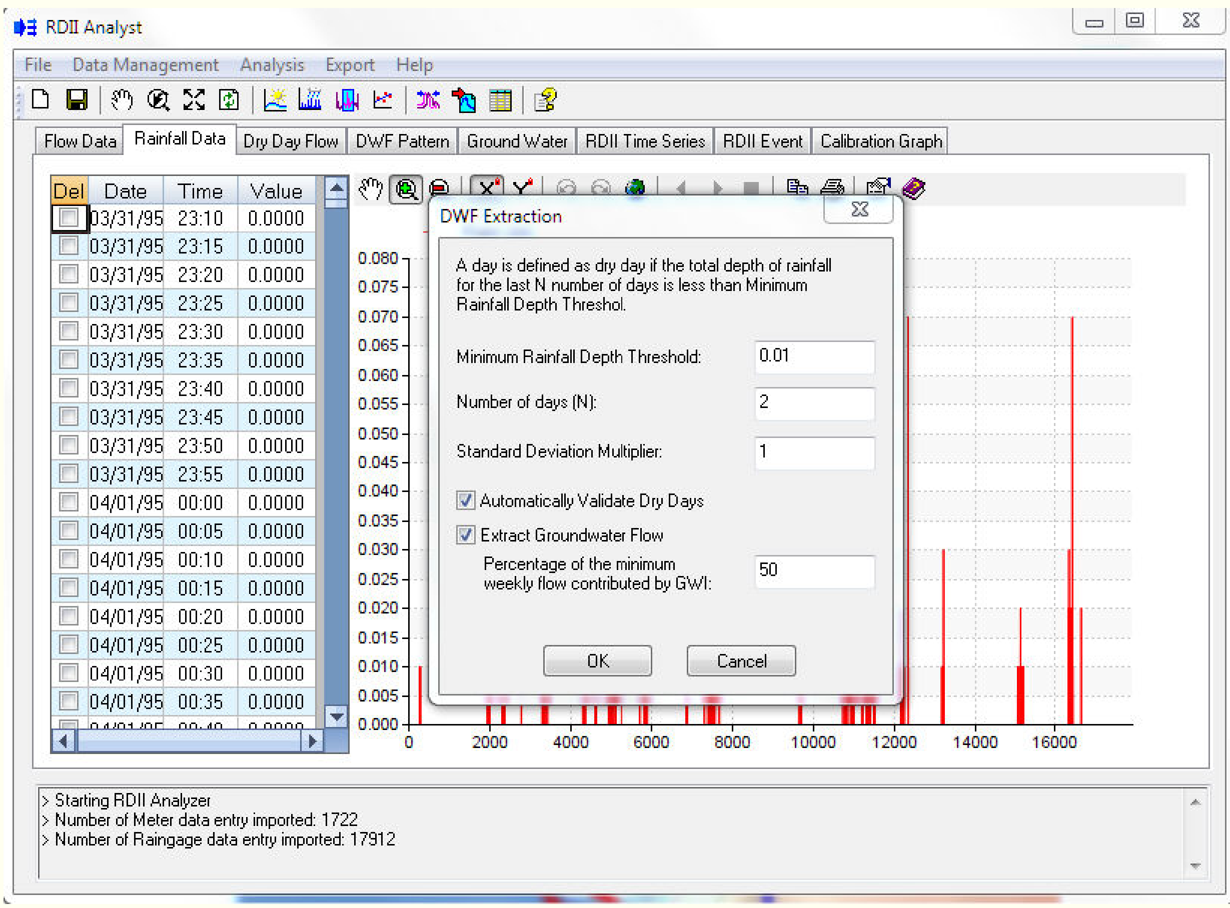
Step 5. Determine the Dry Days, Groundwater Flow and DWF Patterns

To decompose the flow monitoring data into dry weather flows and wet weather flows, RDII Analyst first identifies the dry days based on user specified criteria.

1. Launch

the *DWF Extraction* dialog by clicking () from the toolbar or from the menu select *Analysis -> Extract DWF*.



[

2. Specify

the values shown above for the Minimum Rainfall Depth Threshold, Number of Days and the Standard Deviation Multiplier and click the OK button.

3. The

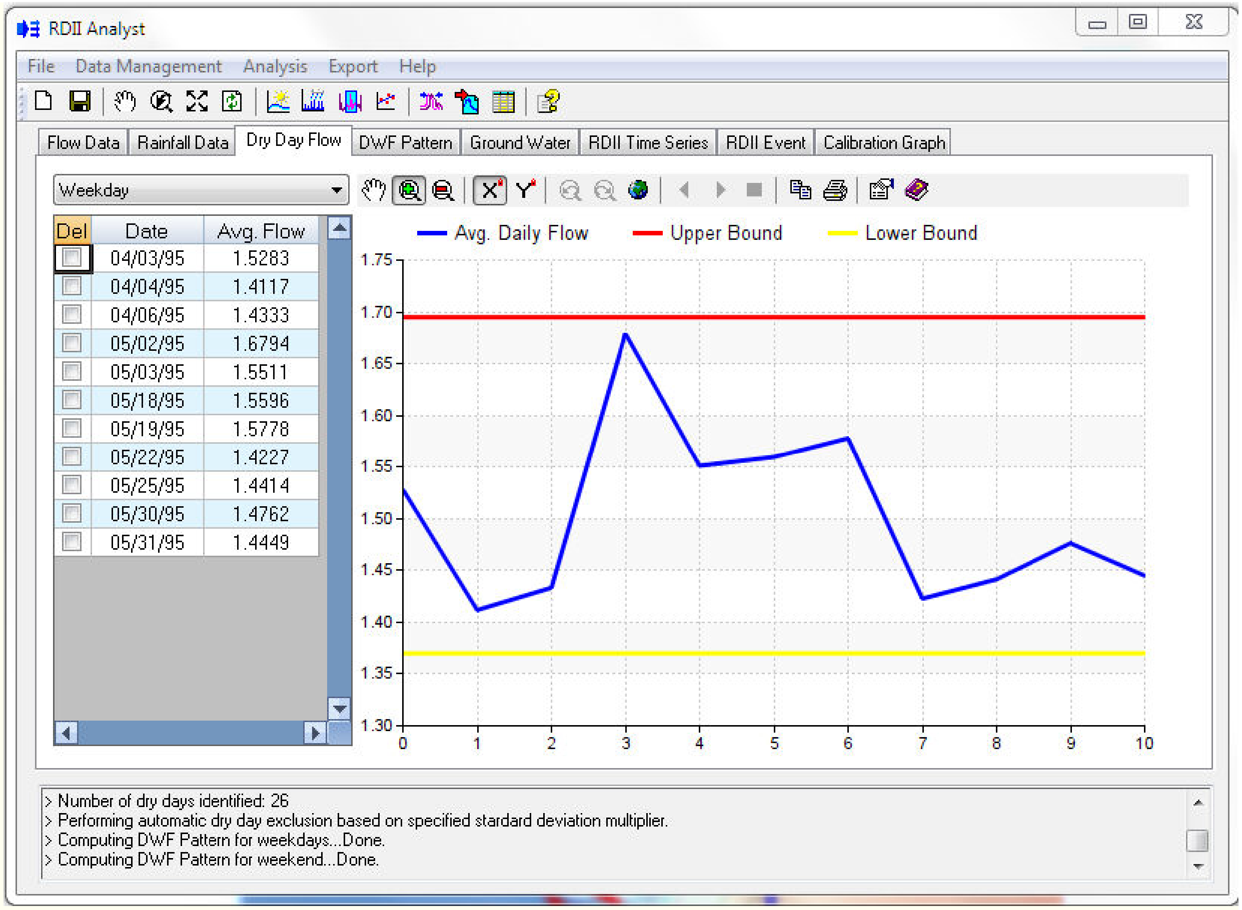
days that satisfy the dry day criteria specified above would be extracted from the flow monitoring data and would be reported along with average daily flow. In addition, mean daily flow and standard deviation of the identified dry days is calculated and the upper bound and the lower bound lines would be given in graph form. The upper bound line refers to the mean daily flow of the dry days plus *Standard Deviation Multiplier**

standard deviation of the dry day flows. The lower bound line refers to the mean daily flow of the dry days minus *Standard Deviation Multiplier**

standard deviation of the dry day flows. If average daily flow for one or more of the dry days is outside the upper bound and the lower bound range, it is likely that the day is an outlier and may have to be discarded from the flow monitoring data and should not be considered for further analysis.

Weekday

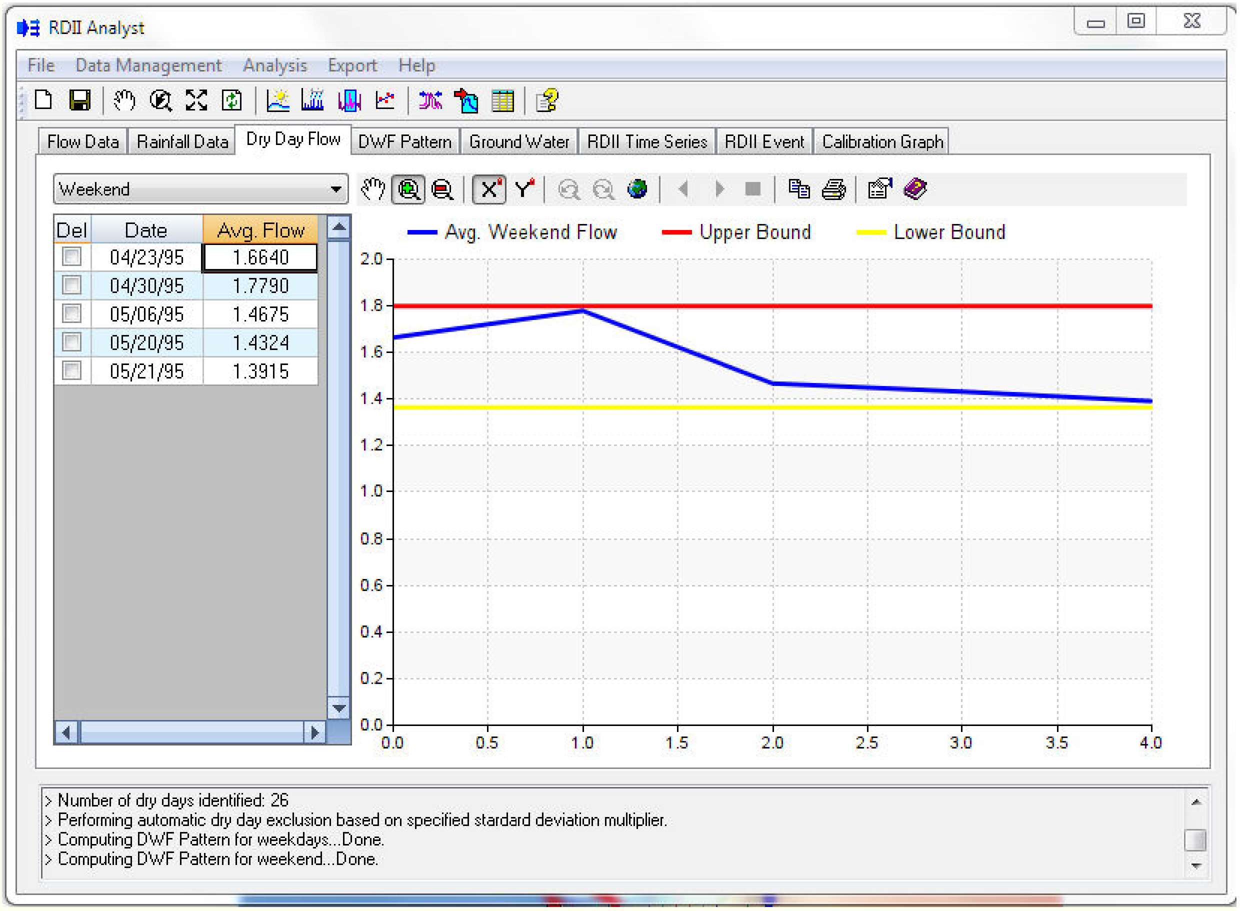
Pattern



4. The

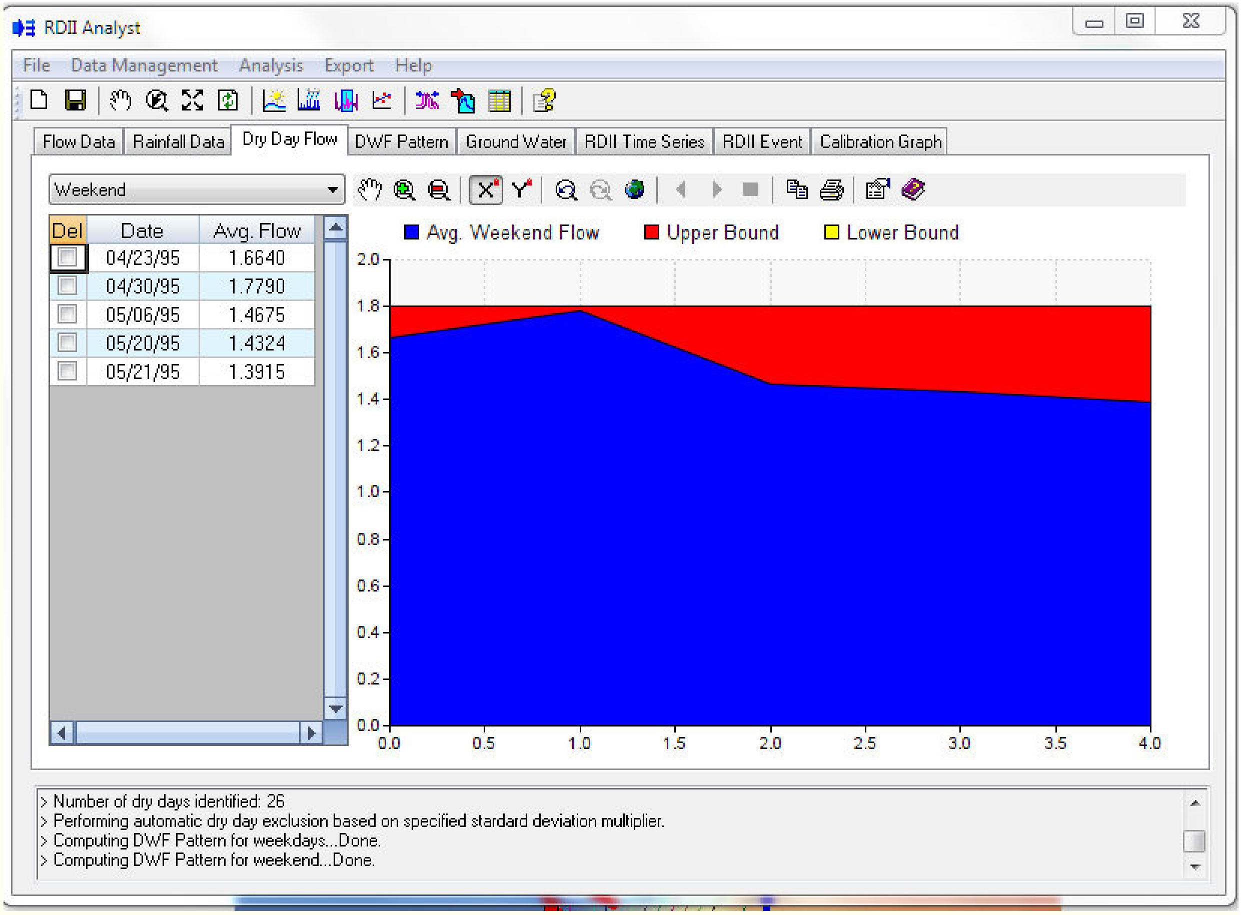
outliers may be deleted manually or automatically. If you wish to delete the outliers automatically, you need to select the **Automatically Validated Dry Days** option and re-run the DWF extraction. To delete the outliers manually, select the outlier data rows with average daily flows outside the bounds as shown below. Click **Delete** at the top of the first column on the report and then click the Save Button (), and click **Yes** at the confirmation message.

Weekend Pattern



5. Once

the outliers are removed you should get the average dry day flow time series shown below.



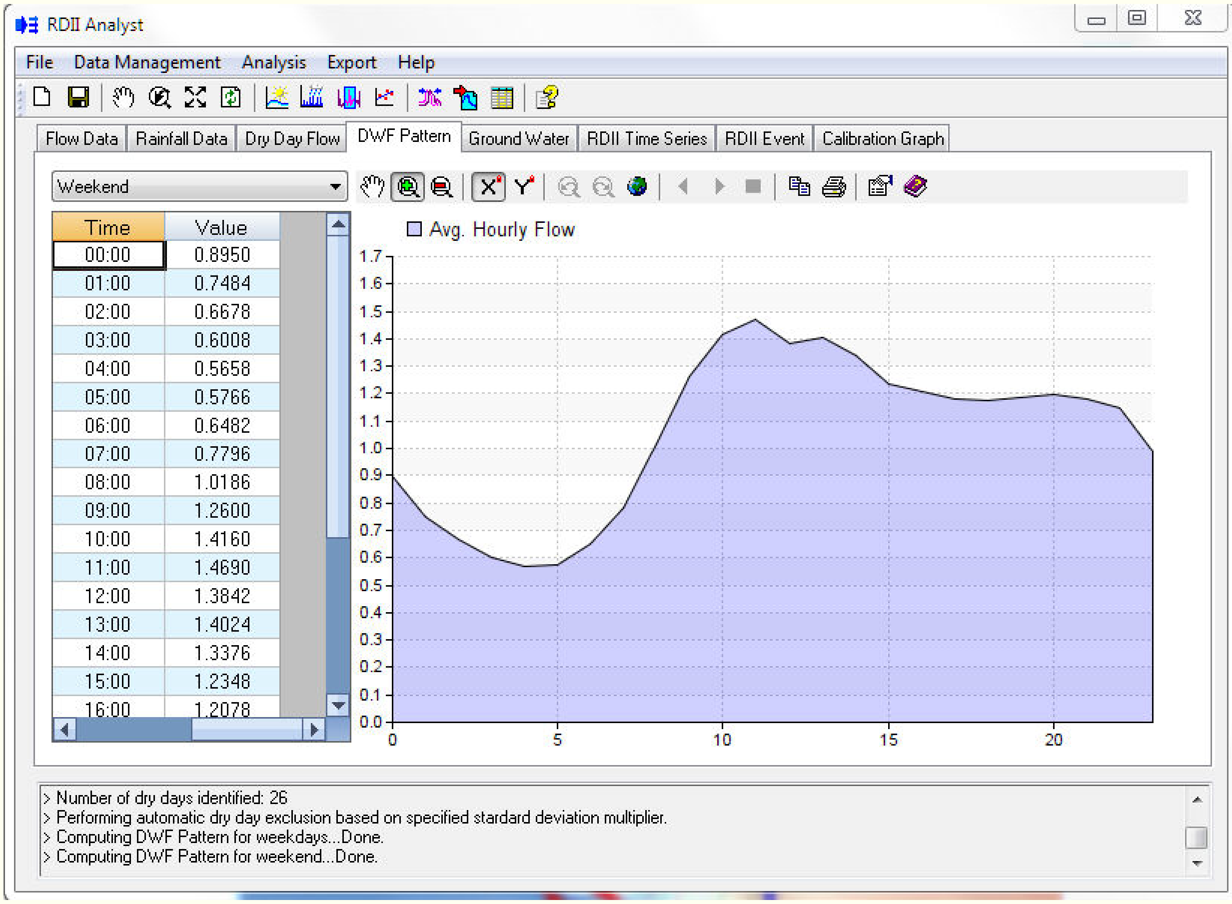
6. *RDII Analyst* can also estimate the groundwater flow contribution to the wastewater flow. Select the **Extract Groundwater Flow** option on the DWF Extraction dialog and specify 0.5 for the **Fraction of the minimum weekly flow contributed by GWI** parameter. *The groundwater flow is estimated*

as a multiple of the minimum weekly flows observed from the dry days. The minimum weekly flows can be rescaled by this user specified multiplier.

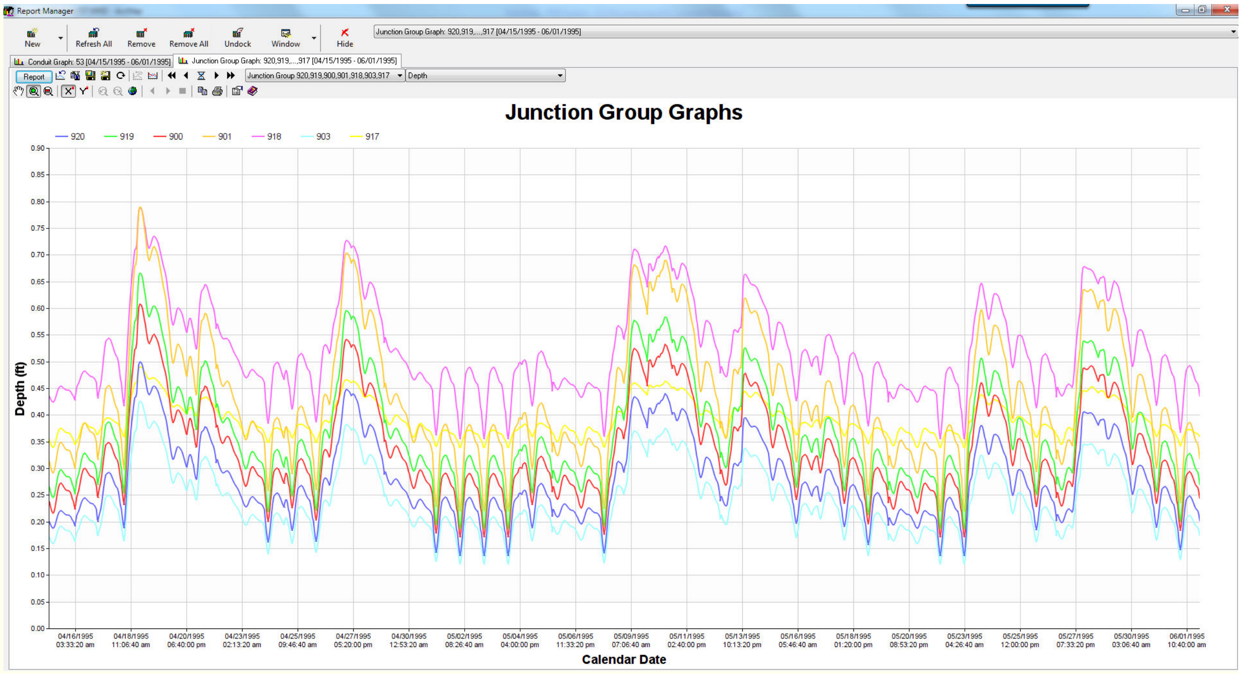
7. Review

the extracted groundwater time series. It has 52 values, one value for each week of the year.

8. Once the dry days are identified, *RDII Analyst* automatically calculates hourly DWF patterns for weekends and weekdays and presents them both graphically and in report form. To view the hourly DWF patterns, click the **DWF Pattern** tab from the graphs and reports list.



9. You can see the DWF Pattern if
you run InfoSWMM and
graph the Lateral Inflow at the Nodes.



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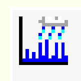
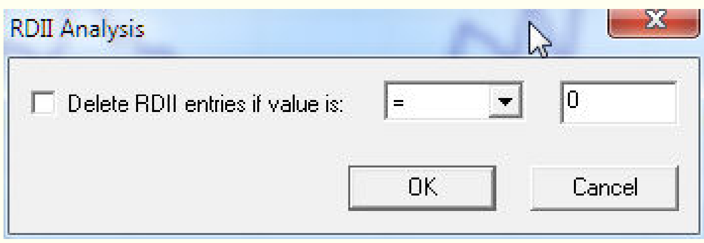
Step 6. Determine the RDII Flow Component

RDII flow would be determined by subtracting the DWF and the groundwater flow components identified by the *RDII Analyst* from the corrected flow monitoring data.

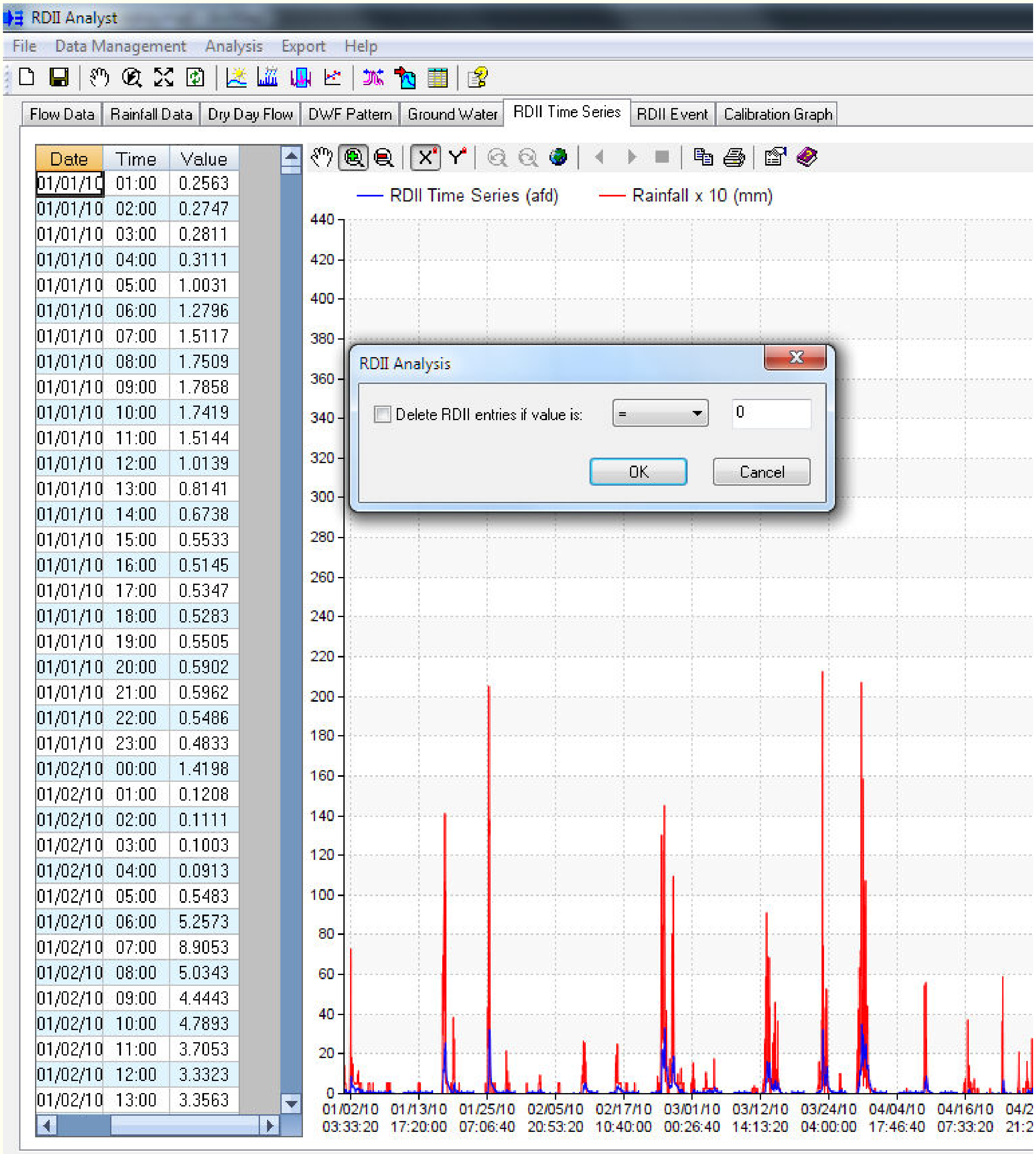
1. To

determine the RDII time series, click the () button on the toolbar, or engage the tool from the menu *Analysis* -> *RDII Analysis* -> *Compute RDII Time Series*. Choose the parameters below.



2. The

RDII time series is provided in graph form and in report format. The RDII time series and the rainfall data are combined for easy visualization of the RDII events and to verify accuracy of the analysis results.


RDII Analyst
File Data Management Analysis Export Help
Flow Data Rainfall Data Dry Day Flow DWF Pattern Ground Water RDII Time Series RDII Event Calibration Graph
Date Time Value
01/01/10 01:00 0.2563
01/01/10 02:00 0.2747
01/01/10 03:00 0.2811
01/01/10 04:00 0.3111
01/01/10 05:00 1.0031
01/01/10 06:00 1.2796
01/01/10 07:00 1.5117
01/01/10 08:00 1.7509
01/01/10 09:00 1.7858
01/01/10 10:00 1.7419
01/01/10 11:00 1.5144
01/01/10 12:00 1.0139
01/01/10 13:00 0.8141
01/01/10 14:00 0.6738
01/01/10 15:00 0.5533
01/01/10 16:00 0.5145
01/01/10 17:00 0.5347
01/01/10 18:00 0.5283
01/01/10 19:00 0.5505
01/01/10 20:00 0.5902
01/01/10 21:00 0.5962
01/01/10 22:00 0.5486
01/01/10 23:00 0.4833
01/02/10 00:00 1.4198
01/02/10 01:00 0.1208
01/02/10 02:00 0.1111
01/02/10 03:00 0.1003
01/02/10 04:00 0.0913
01/02/10 05:00 0.5483
01/02/10 06:00 5.2573
01/02/10 07:00 8.9053
01/02/10 08:00 5.0343
01/02/10 09:00 4.4443
01/02/10 10:00 4.7893
01/02/10 11:00 3.7053
01/02/10 12:00 3.3323
01/02/10 13:00 3.3563
RDII Time Series (afd)
Rainfall x 10 (mm)
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
01/02/10 03:33:20
01/13/10 17:20:00
01/25/10 07:06:40
02/05/10 20:53:20
02/17/10 10:40:00
03/01/10 00:26:40
03/12/10 14:13:20
03/24/10 04:00:00
04/04/10 17:46:40
04/16/10 07:33:20
RDII Analysis
Delete RDII entries if value is:
=
0
OK
Cancel

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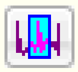
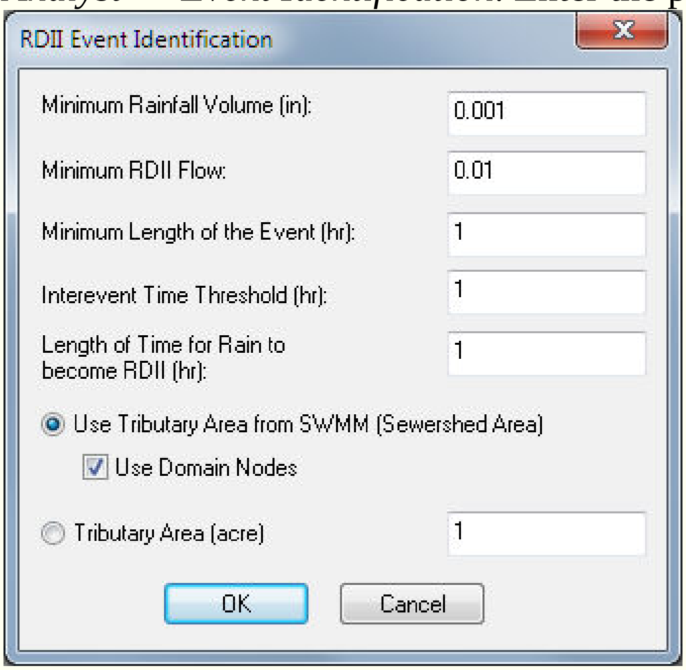
Step 7. Determine RDII Events

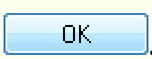
The RDII time series can be further analyzed to determine RDII events and to summarize each event.

1. Click

the () button from the toolbar, or from the menu *Analysis -> RDII Analyst -> Event Identification*. Enter the parameter values as shown below.

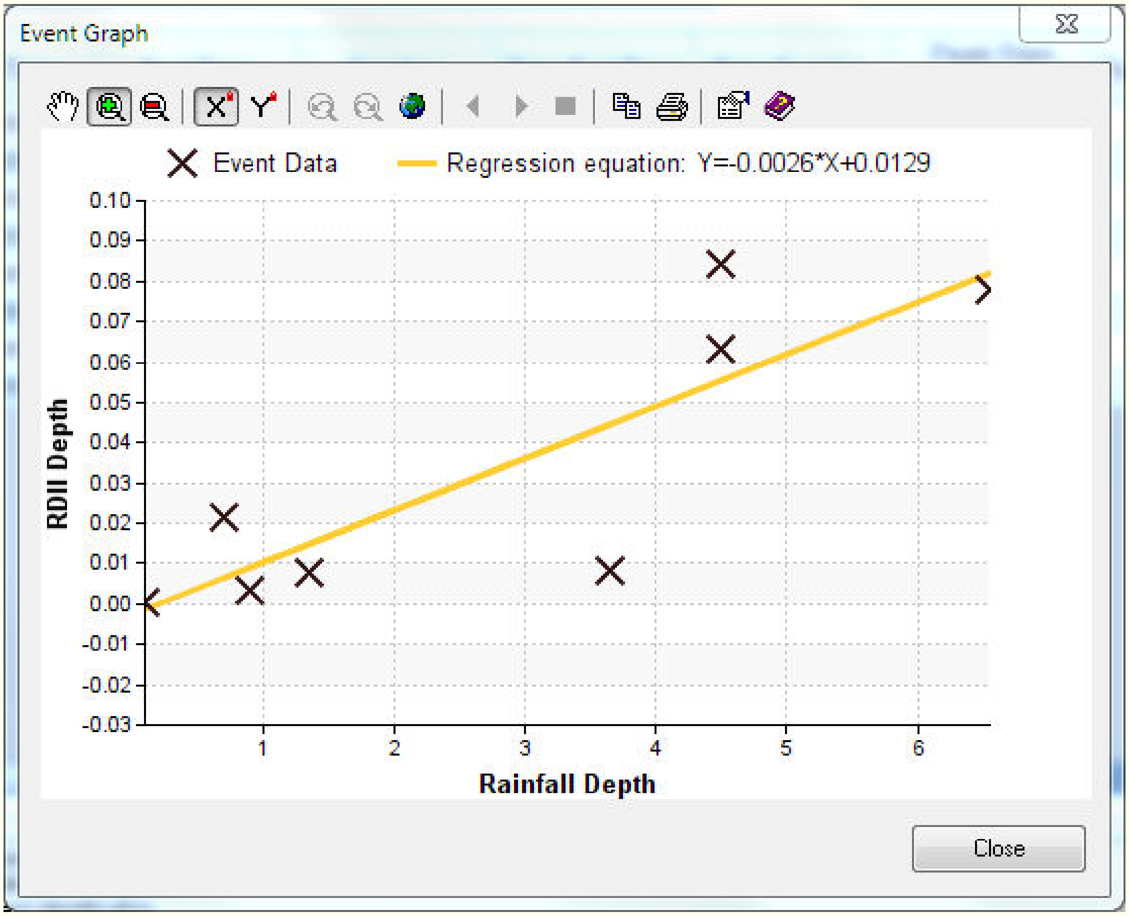


2. Click



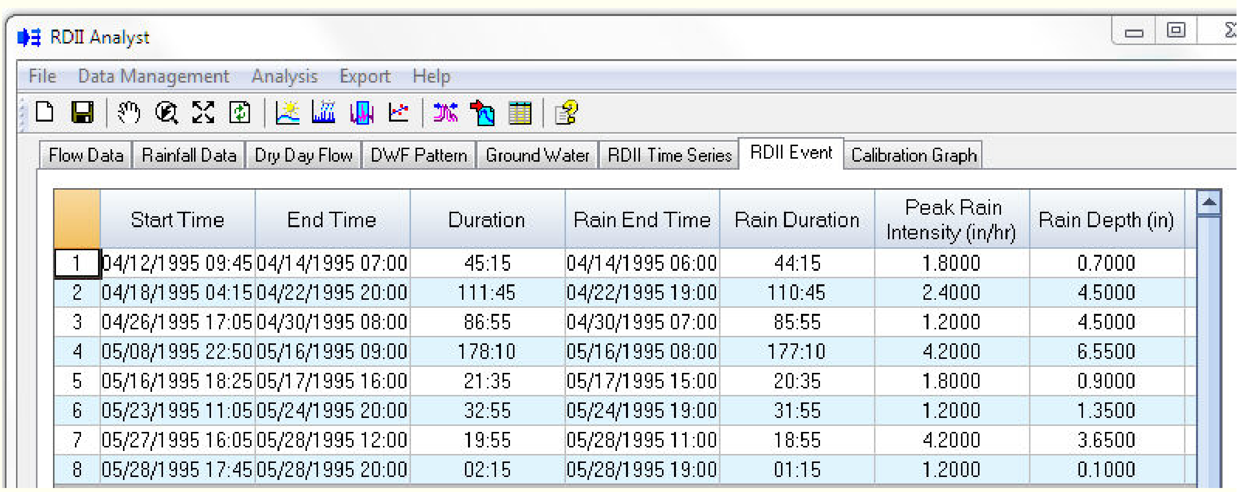
.

A linear regression equation that describes RDII volume as a function of rainfall depth for the RDII events would be developed. The linear regression result and summary of each RDII event would be reported as shown below.



3. The

RDII Event Identification Table



	Start Time	End Time	Duration	Rain End Time	Rain Duration	Peak Rain Intensity (in/hr)	Rain Depth (in)
1	04/12/1995 09:45	04/14/1995 07:00	45:15	04/14/1995 06:00	44:15	1.8000	0.7000
2	04/18/1995 04:15	04/22/1995 20:00	111:45	04/22/1995 19:00	110:45	2.4000	4.5000
3	04/26/1995 17:05	04/30/1995 08:00	86:55	04/30/1995 07:00	85:55	1.2000	4.5000
4	05/08/1995 22:50	05/16/1995 09:00	178:10	05/16/1995 08:00	177:10	4.2000	6.5500
5	05/16/1995 18:25	05/17/1995 16:00	21:35	05/17/1995 15:00	20:35	1.8000	0.9000
6	05/23/1995 11:05	05/24/1995 20:00	32:55	05/24/1995 19:00	31:55	1.2000	1.3500
7	05/27/1995 16:05	05/28/1995 12:00	19:55	05/28/1995 11:00	18:55	4.2000	3.6500
8	05/28/1995 17:45	05/28/1995 20:00	02:15	05/28/1995 19:00	01:15	1.2000	0.1000

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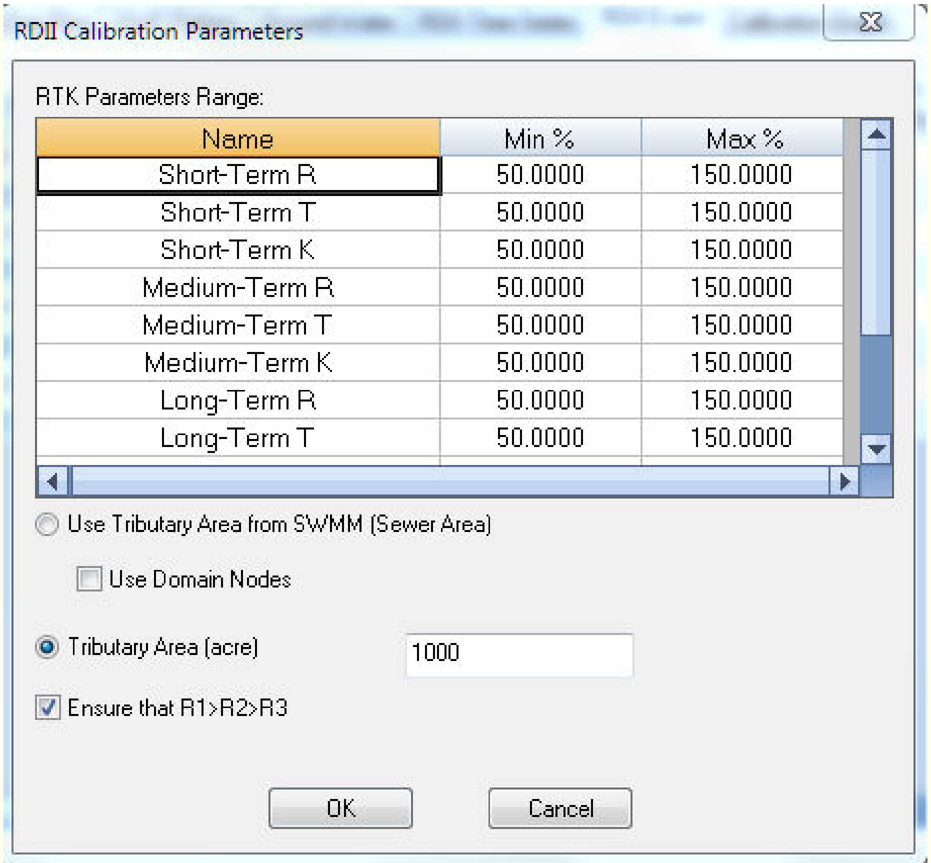
Step 8. Calibrate the RTK Hydrograph Parameters

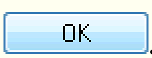
Automated calibration is another powerful tool that *RDII Analyst* offers. The calibration tool identifies optimal parameters of the RTK hydrograph to match the RDII flow simulated by H2OMAP SWMM with the RDII time series identified by *RDII Analyst* using the decomposition process described previously. The RTK parameters that can be calibrated may be selected by the user from the 12 parameters available to choose from.

1. You

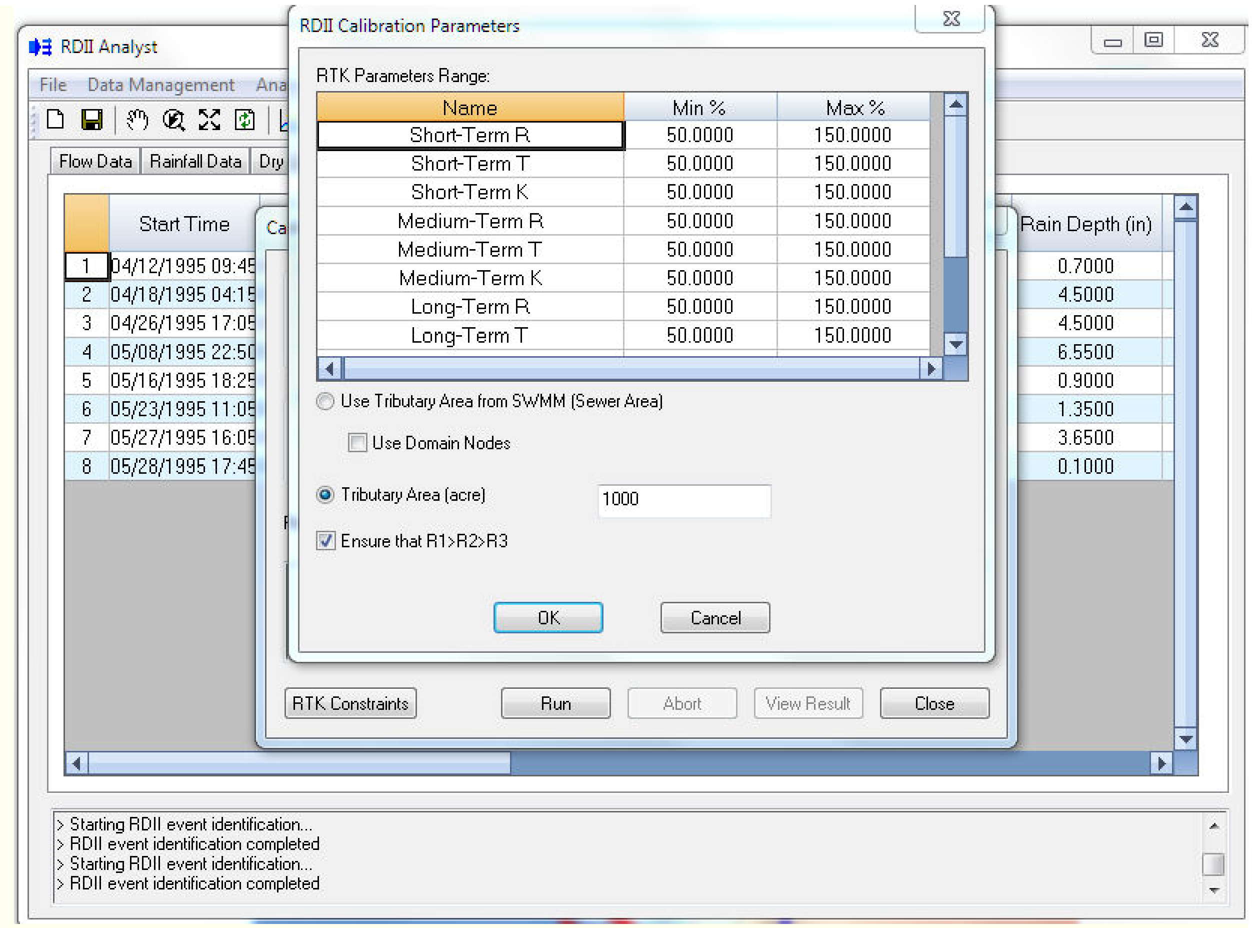
may initiate the *RDII Calibration Parameters* page by clicking the () button from the toolbar or from the menu *Analysis -> Calibrate RDII Parameters*. Specify the minimum and the maximum ranges shown below for each parameter.



2. Click

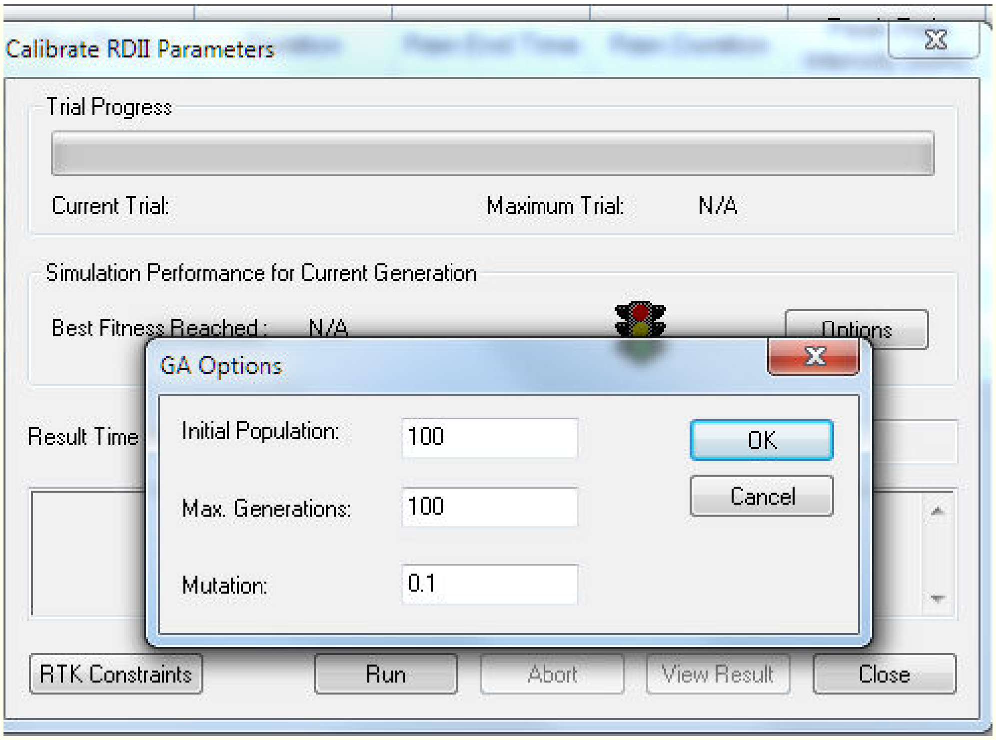


. The *Calibrate RDII Parameters* dialog editor would be initiated.



3. Click

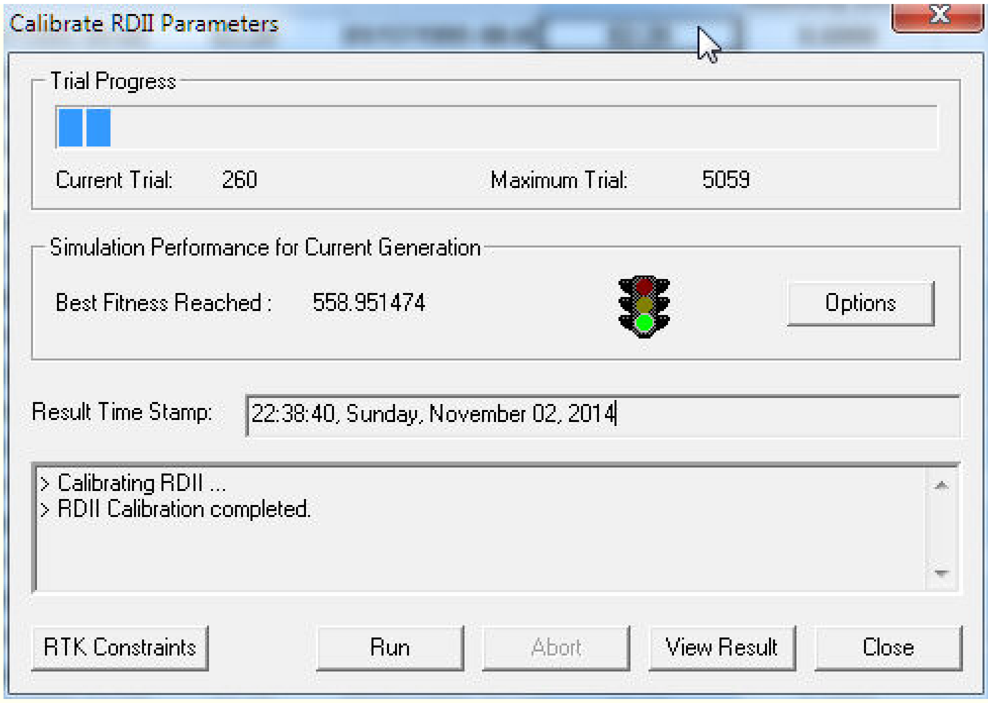
the **Options** button to adjust the GA Options to match the following.

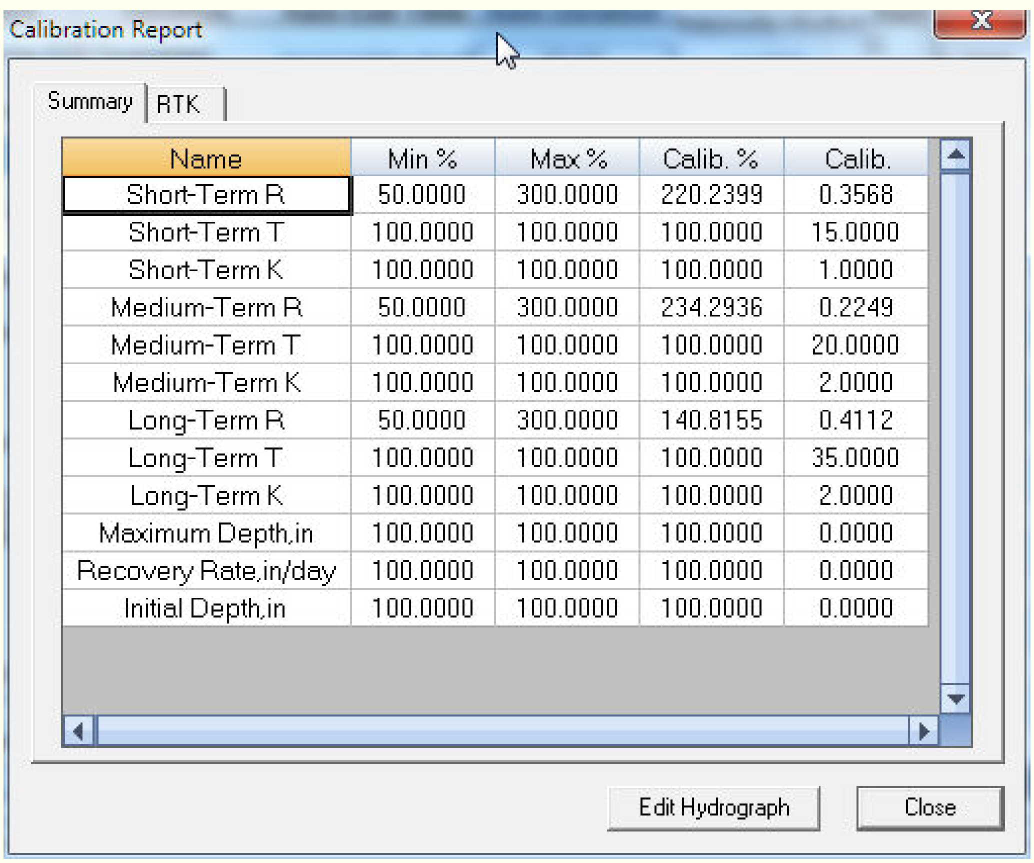


4. Click

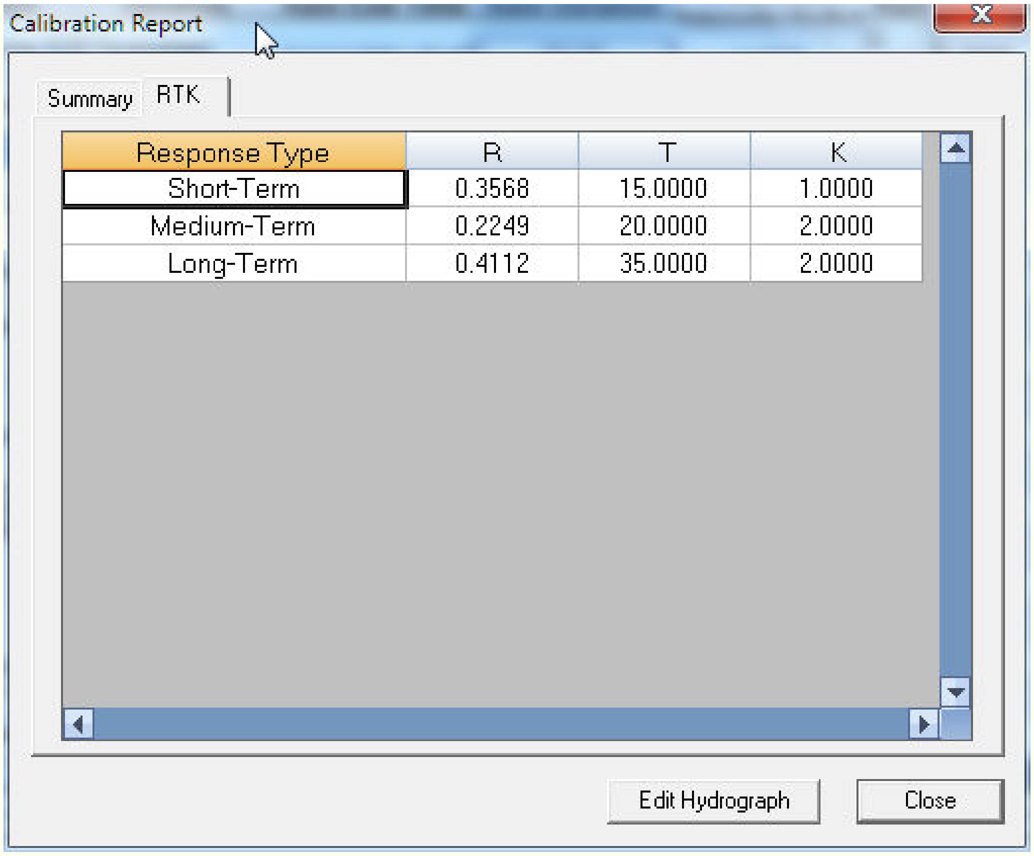
the **Run** button. The number of trial runs made so far, the maximum number of trials to be made and the best fitness obtained from the trail runs made so far would be shown while the model is running.

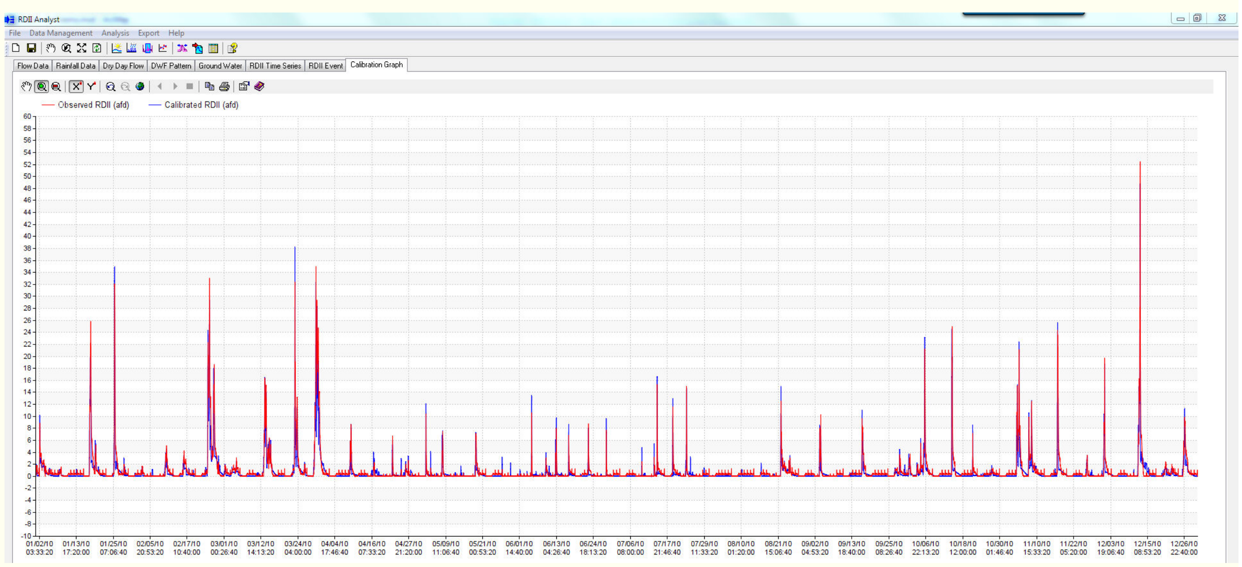
If there is no significant improvement in the fitness for some time (i.e., from generation to generation), then the calibration process would be stopped. Once the calibration run is completed, the RDII flow simulated by the optimal RTK parameters identified by the calibration process would be compared graphically with the RDII time series obtained from the decomposition process. In addition, the optimal RTK parameters identified by the model would also be presented in report form as shown below.





Name	Min %	Max %	Calib. %	Calib.
Short-Term R	50.0000	300.0000	220.2399	0.3568
Short-Term T	100.0000	100.0000	100.0000	15.0000
Short-Term K	100.0000	100.0000	100.0000	1.0000
Medium-Term R	50.0000	300.0000	234.2936	0.2249
Medium-Term T	100.0000	100.0000	100.0000	20.0000
Medium-Term K	100.0000	100.0000	100.0000	2.0000
Long-Term R	50.0000	300.0000	140.8155	0.4112
Long-Term T	100.0000	100.0000	100.0000	35.0000
Long-Term K	100.0000	100.0000	100.0000	2.0000
Maximum Depth,in	100.0000	100.0000	100.0000	0.0000
Recovery Rate,in/day	100.0000	100.0000	100.0000	0.0000
Initial Depth,in	100.0000	100.0000	100.0000	0.0000


Calibration Report
Summary
RTK
Response Type
R
T
K
Short-Term
0.3568
15.0000
1.0000
Medium-Term
0.2249
20.0000
2.0000
Long-Term
0.4112
35.0000
2.0000
Edit Hydrograph
Close


RDII Analyst
File
Data Management
Analysis
Export
Help
Flow Data
Rainfall Data
Dry Day Flow
DWF Pattern
Ground Water
RDII Time Series
RDII Event
Calibration Graph
Observed RDII (afd)
Calibrated RDII (afd)

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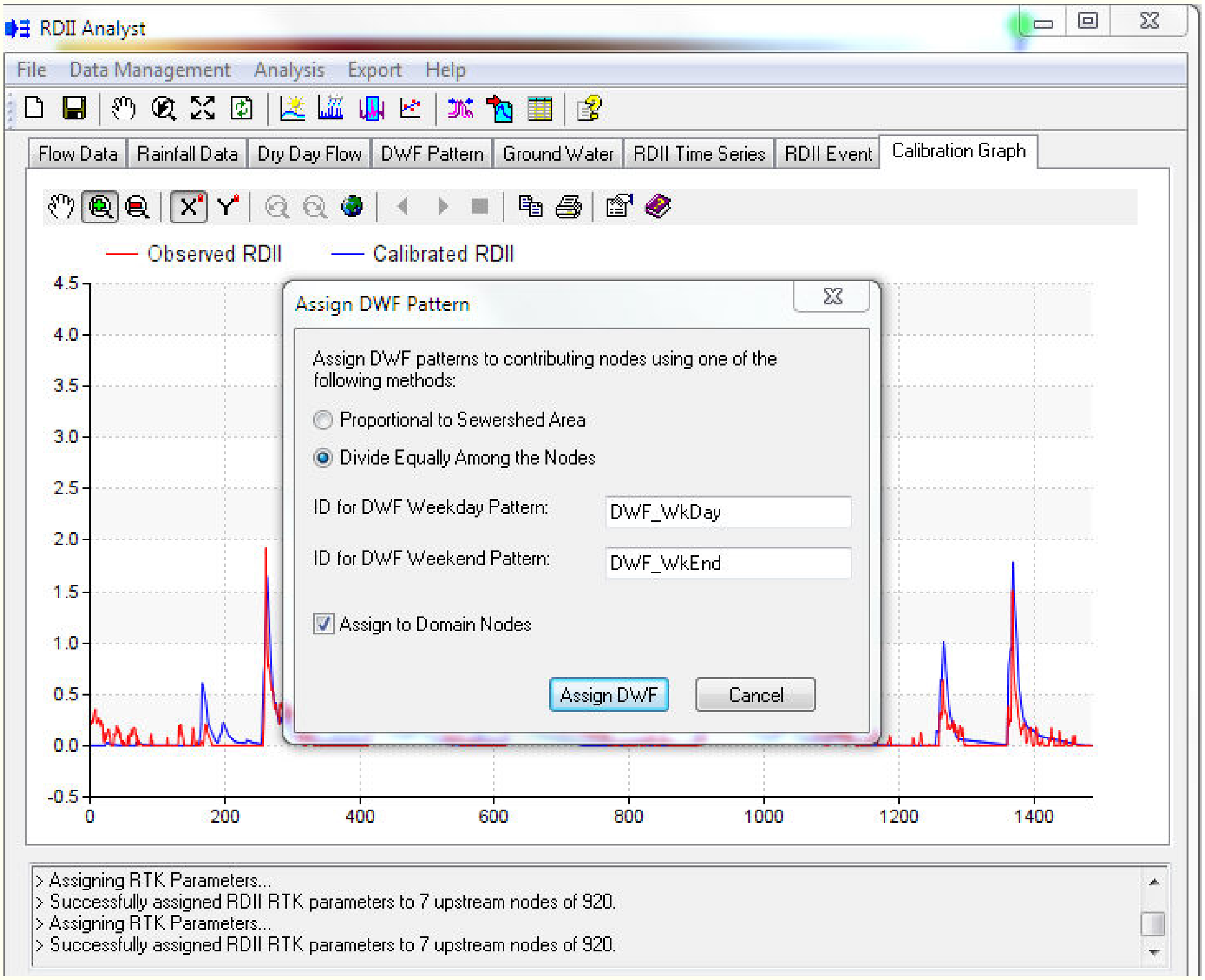
Step 9: Export Results to InfoSWMM

In this section, you will export the hourly DWF patterns created for weekdays and weekend, the groundwater inflow time series and the RTK parameters toInfoSWMM .

The exported data would be assigned to the nodes that contribute flow to the meter location. The allocation would be done equally among the contributing nodes. You can also save the corrected flow data and rainfall data, and the hourly DWF flow patterns to a file for later use.

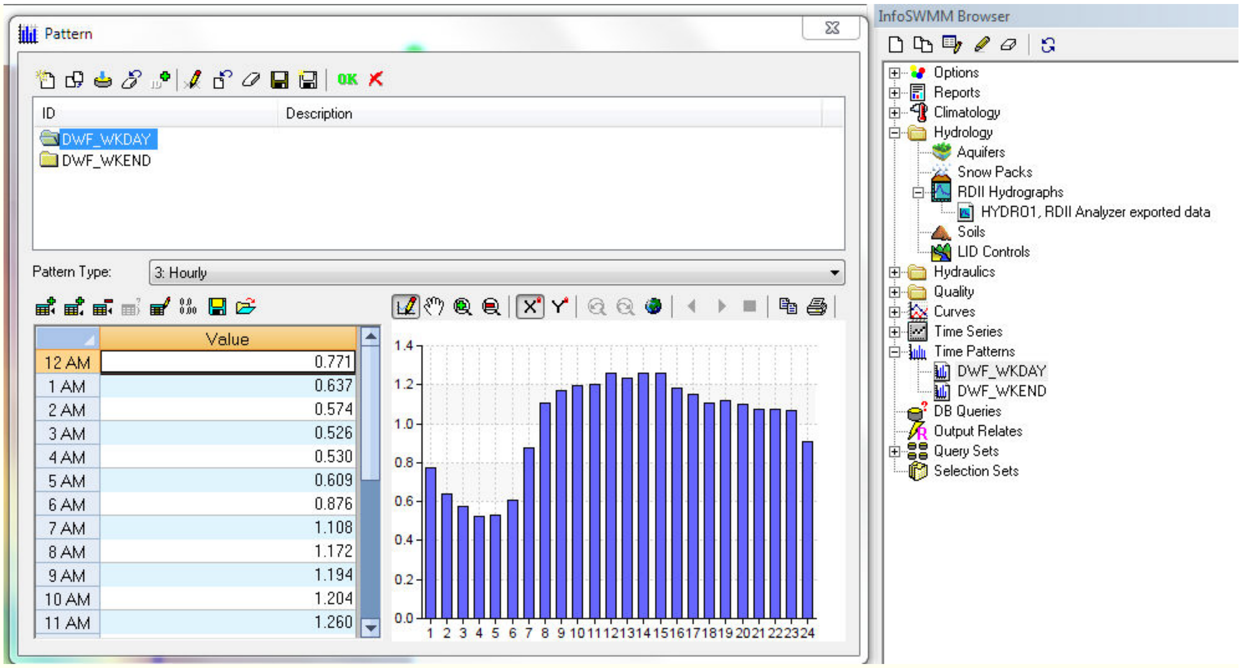
1. From

the menu go to *Export* -> *Assign DWF Pattern*. The following dialog editor is initiated. Specify the options shown below, and then click **Assign DWF**.



2. The DWf Patterns

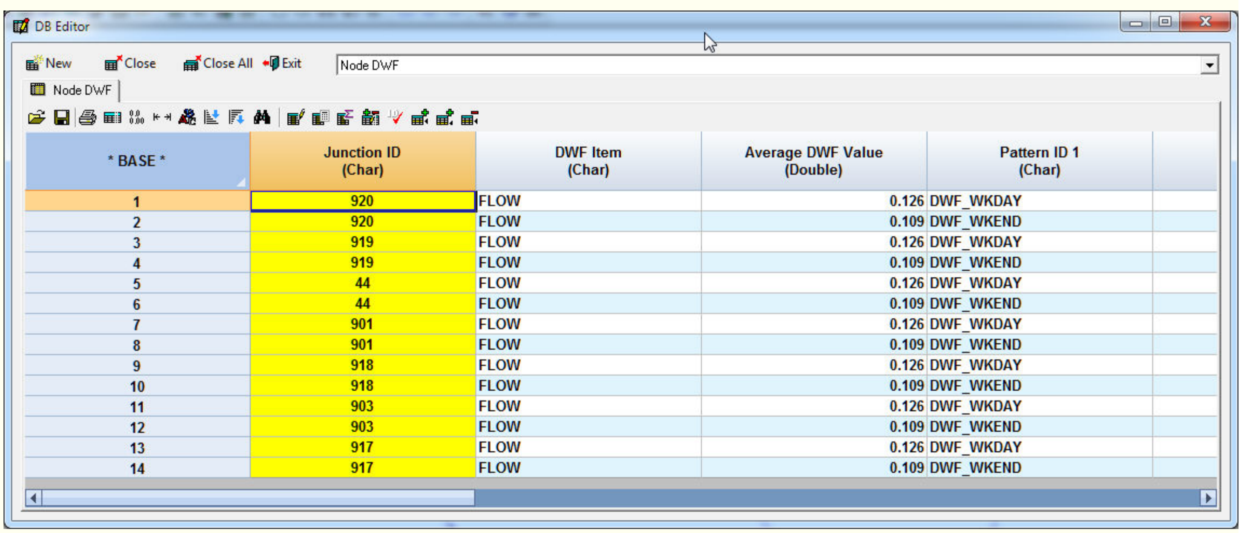
for both Weekend and Weekday are exported to the Patterns DB Table of Innovyze SWMM. These patterns can be seen in the operations tab of the Attribute Browser (AB)



3. Note:

After closing RDII Analyst, from InfoSWMM ,

select any node on the upstream side of *Junction 920*, and click on the ( ) button from the top of the Attribute Browser, then click on the **Dry Weather** tab and notice that hourly DWF patterns for the weekdays and the weekend are assigned to the node.

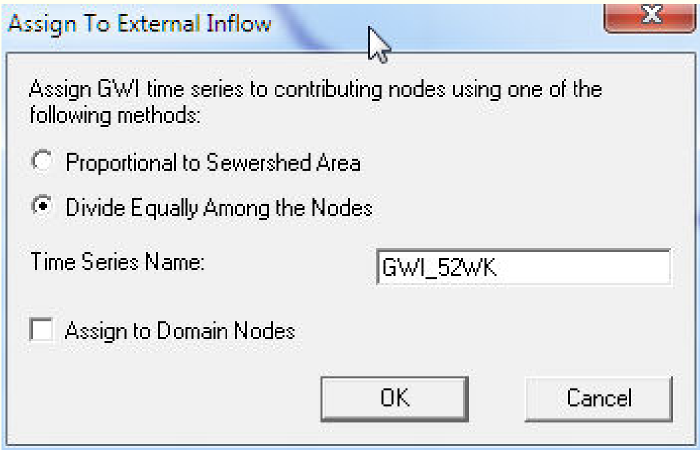


* BASE *	Junction ID (Char)	DWF Item (Char)	Average DWF Value (Double)	Pattern ID 1 (Char)
1	920	FLOW	0.126	DWF_WKDAY
2	920	FLOW	0.109	DWF_WKEND
3	919	FLOW	0.126	DWF_WKDAY
4	919	FLOW	0.109	DWF_WKEND
5	44	FLOW	0.126	DWF_WKDAY
6	44	FLOW	0.109	DWF_WKEND
7	901	FLOW	0.126	DWF_WKDAY
8	901	FLOW	0.109	DWF_WKEND
9	918	FLOW	0.126	DWF_WKDAY
10	918	FLOW	0.109	DWF_WKEND
11	903	FLOW	0.126	DWF_WKDAY
12	903	FLOW	0.109	DWF_WKEND
13	917	FLOW	0.126	DWF_WKDAY
14	917	FLOW	0.109	DWF_WKEND

4. To

export the groundwater flow time series, click *GWI Time Series* from the *Export* menu. Select the following options on

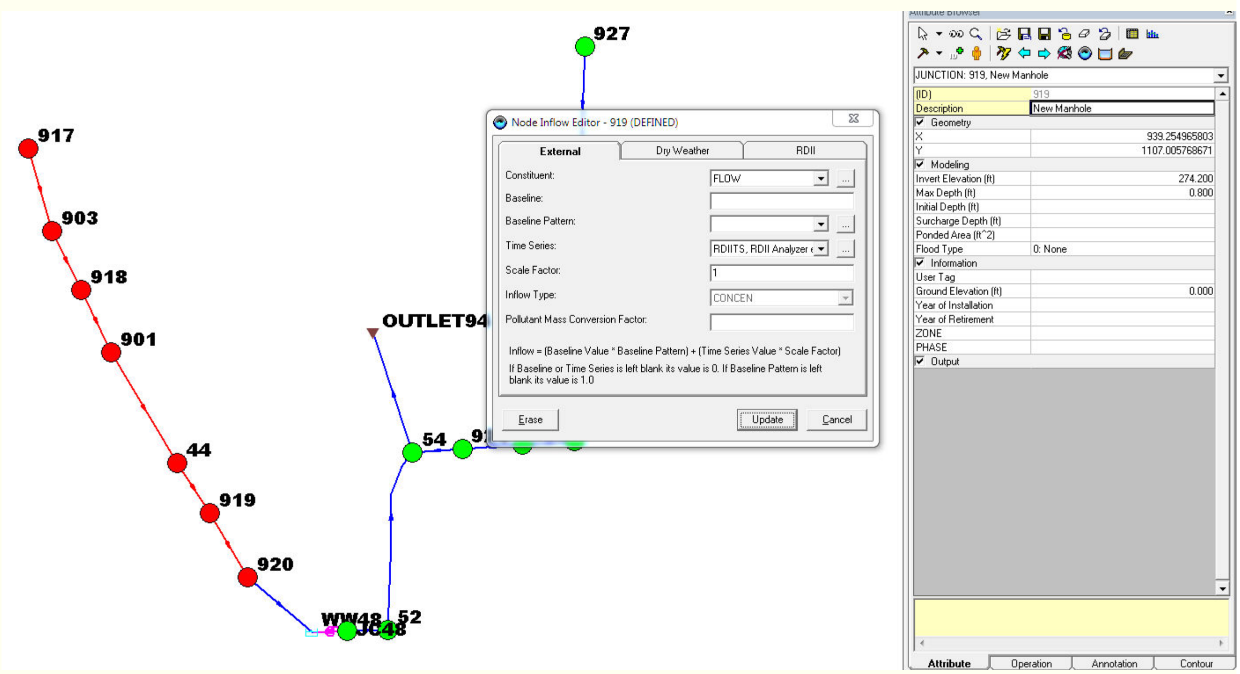
the initiated dialog box, and then click **OK**.



5. Note:

After closing RDII Analyst, fromInfoSWMM ,

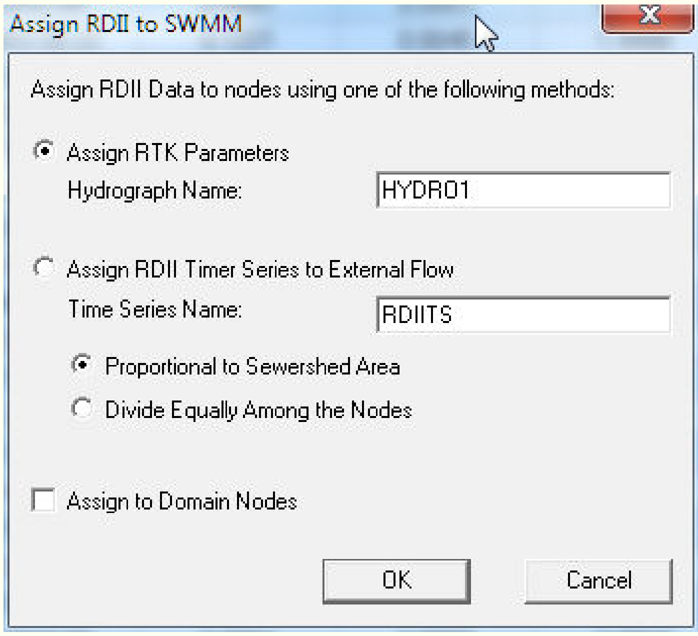
click on any node on the upstream side of *Junction 920*, and click on the () button from the top of the Attribute Browser, then click on the **External** tab and notice that the groundwater time series is assigned to the node.



6. To

export the RTK parameters, click Assign RDII Time Series from the *Export* menu. Select the following options on the initiated dialog

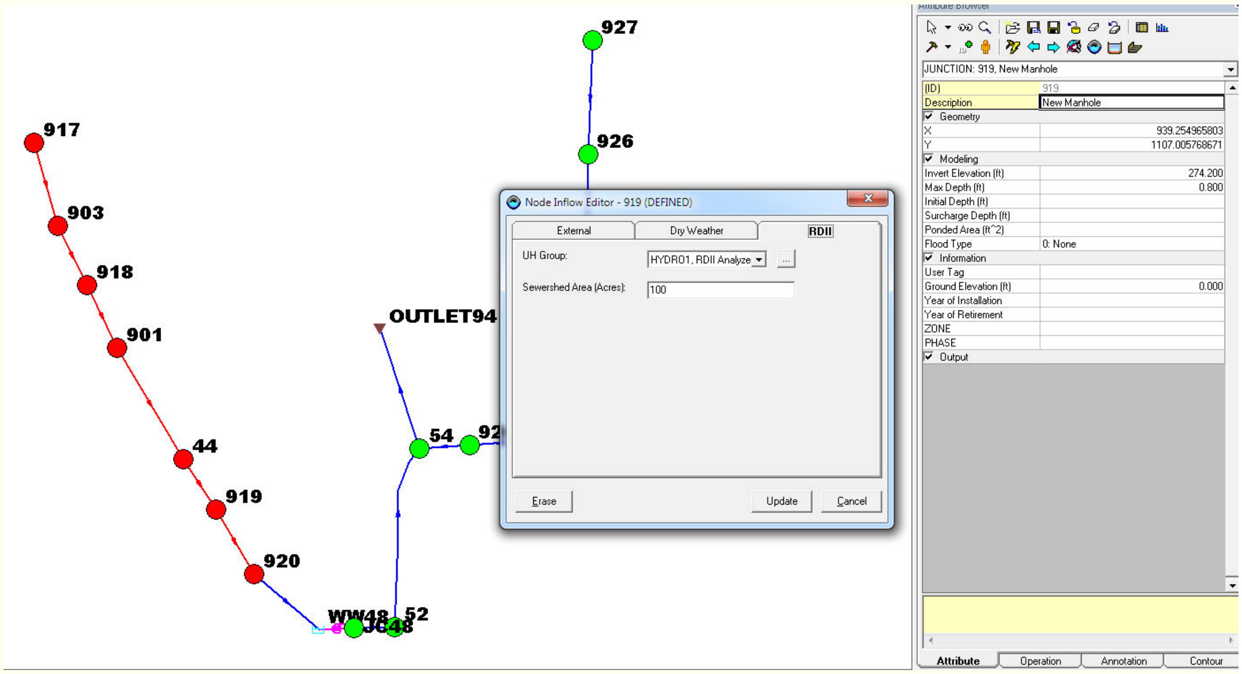
box, and then click **OK**.



7. Note:

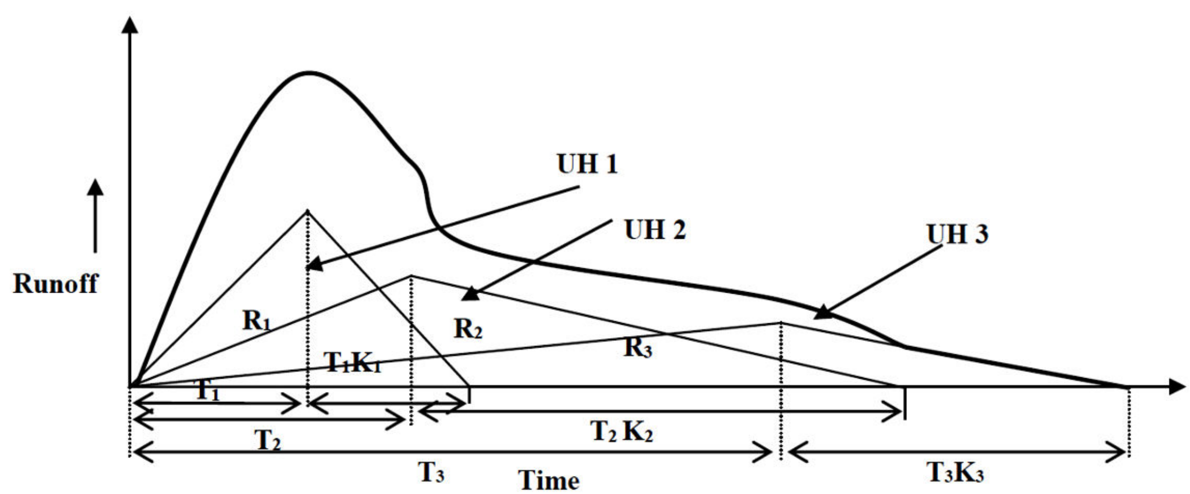
After closing RDII Analyst, from InfoSWMM ,

click on any node on the upstream side of *Junction 920*, and click on the () button from the top of the Attribute Browser, then click on the **RDII** tab and notice that the RTK parameters assigned to the hydrograph are the same as the optimal parameters identified by the calibration process.

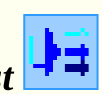


How the R (rainfall to

flow fraction) and the T and K parameters (T*K or the Base of the Unit Hydrograph) are related visually. There are three R, three T or time parameters and three K parameters.



Congratulations! You

have now completed the Quick Start Tutorial of ***RDII Analyst*** 

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Rainfall and Flow Example Format

The format of the rainfall and flow files used in this tutorial. The rainfall file has tabs, whereas the flow file is space delimited.

Rainfall Format

FIle links for Rainfall and Flow

C:\Users\Public\Documents\InfoSWMM\Examples\FlowData.TXT

C:\Users\Public\Documents\InfoSWMM\Examples\RainfallData.txt The top of the Flow Data File looks like

SITE DATE HOUR

FLOW (cfs)

------ ---------- ---- ----------

MS0350 03/30/1995 23 1.815

MS0350 03/31/1995 0 1.624

The top of the Rain Data File looks like

Year Month Date hour MIN WS1218 WS1209 WS1207 WS1202 WS1206 WS1204 WS1203

WS1216 WS1202

3/31/1995 23:0 1995 3 31 23 0 0 0 0 0 0 0 0 0 0 0

3/31/1995 23:5 1995 3 31 23 5 0 0 0 0 0 0 0 0 0 0

```
▌▌Year▌Month▌Date▌hour▌MIN▌WS1218▌WS1209▌WS1207▌WS1202▌WS1206▌WS1204▌WS1203▌WS1216▌WS1202▌▌▌
▌▌1994▌12▌31▌24▌0▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
1/1/1995▌0:5▌1995▌1▌1▌0▌5▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
1/1/1995▌0:10▌1995▌1▌1▌0▌10▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
1/1/1995▌0:15▌1995▌1▌1▌0▌15▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
1/1/1995▌0:20▌1995▌1▌1▌0▌20▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
1/1/1995▌0:25▌1995▌1▌1▌0▌25▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
1/1/1995▌0:30▌1995▌1▌1▌0▌30▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
1/1/1995▌0:35▌1995▌1▌1▌0▌35▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
1/1/1995▌0:40▌1995▌1▌1▌0▌40▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
1/1/1995▌0:45▌1995▌1▌1▌0▌45▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
1/1/1995▌0:50▌1995▌1▌1▌0▌50▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
1/1/1995▌0:55▌1995▌1▌1▌0▌55▌0▌0▌0▌0▌0▌0▌0▌0▌0▌▌▌0
```

Flow Format

```
 SITE       DATE      HOUR  FLOW (cfs)
------  ----------  ----  ----------
MS0350  01/01/1993     0       0.000
MS0350  01/01/1993     1       0.000
MS0350  01/01/1993     2       0.000
MS0350  01/01/1993     3       0.000
MS0350  01/01/1993     4       0.000
MS0350  01/01/1993     5       0.000
MS0350  01/01/1993     6       0.000
MS0350  01/01/1993     7       0.000
MS0350  01/01/1993     8       0.000
MS0350  01/01/1993     9       0.000
MS0350  01/01/1993    10       0.000
```

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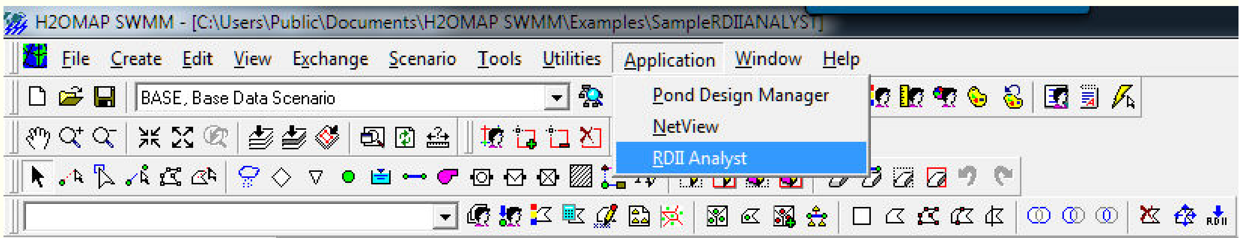
Step 4/2. Initialize RDII Analyst

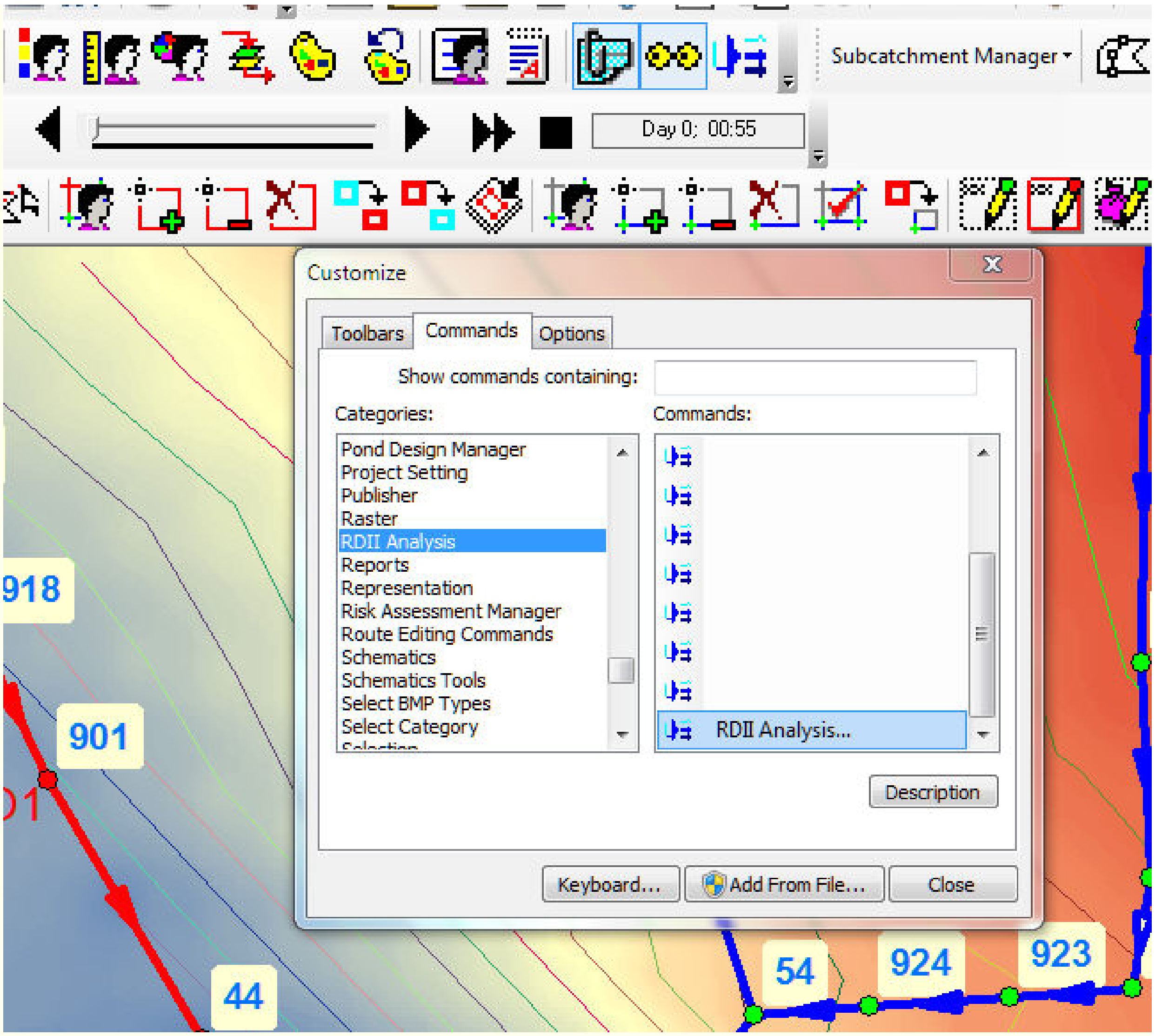
1. Initialize

RDII Analyst by selecting RDII Analysis from theInfoSWMM

Applications menu:



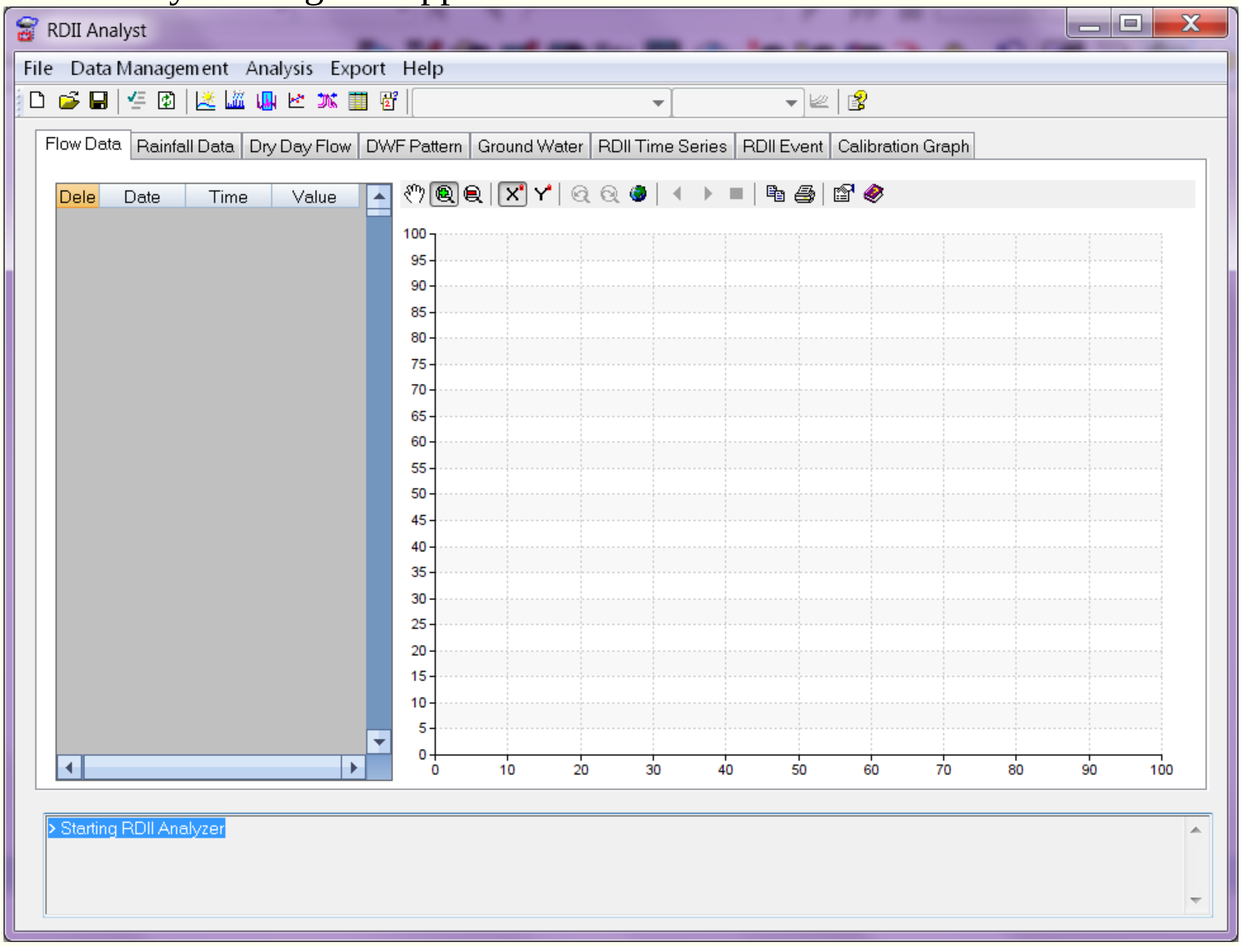
2. You can also make a custom Icon for RDII Analyst using the Customize Menu command of Arc Map (InfoSWMM Only) and then use that Icon to open RDII Analyst.



Subcatchment Manager
Day 0; 00:55
Customize
Toolbars
Commands
Options
Show commands containing:
Categories:
Commands:
Pond Design Manager
Project Setting
Publisher
Raster
RDII Analysis
Reports
Representation
Risk Assessment Manager
Route Editing Commands
Schematics
Schematics Tools
Select BMP Types
Select Category
RDII Analysis...
Description
Keyboard...
Add From File...
Close
918
901
44
54
924
923

3. The

RDII Analyst dialog box appears:



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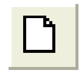
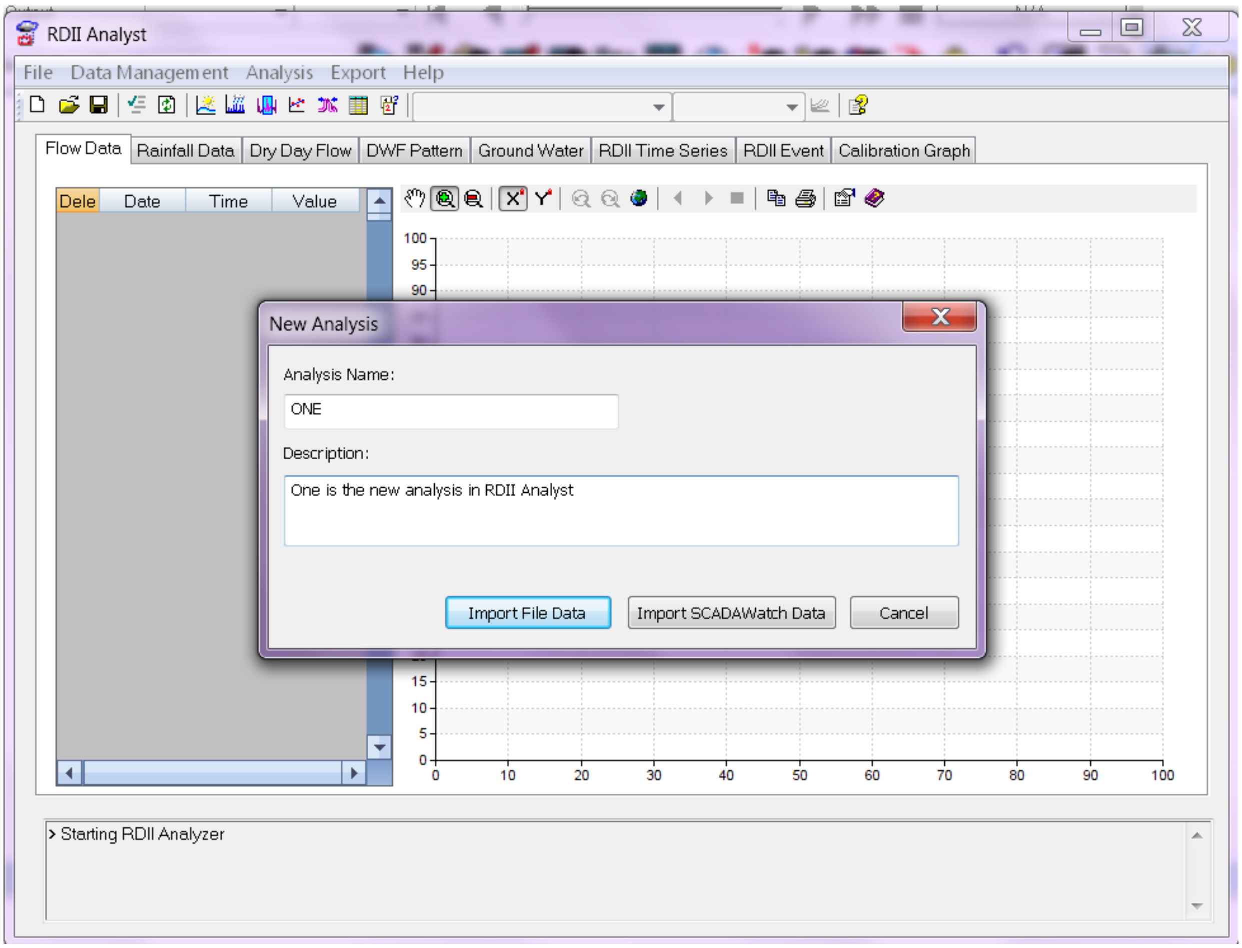
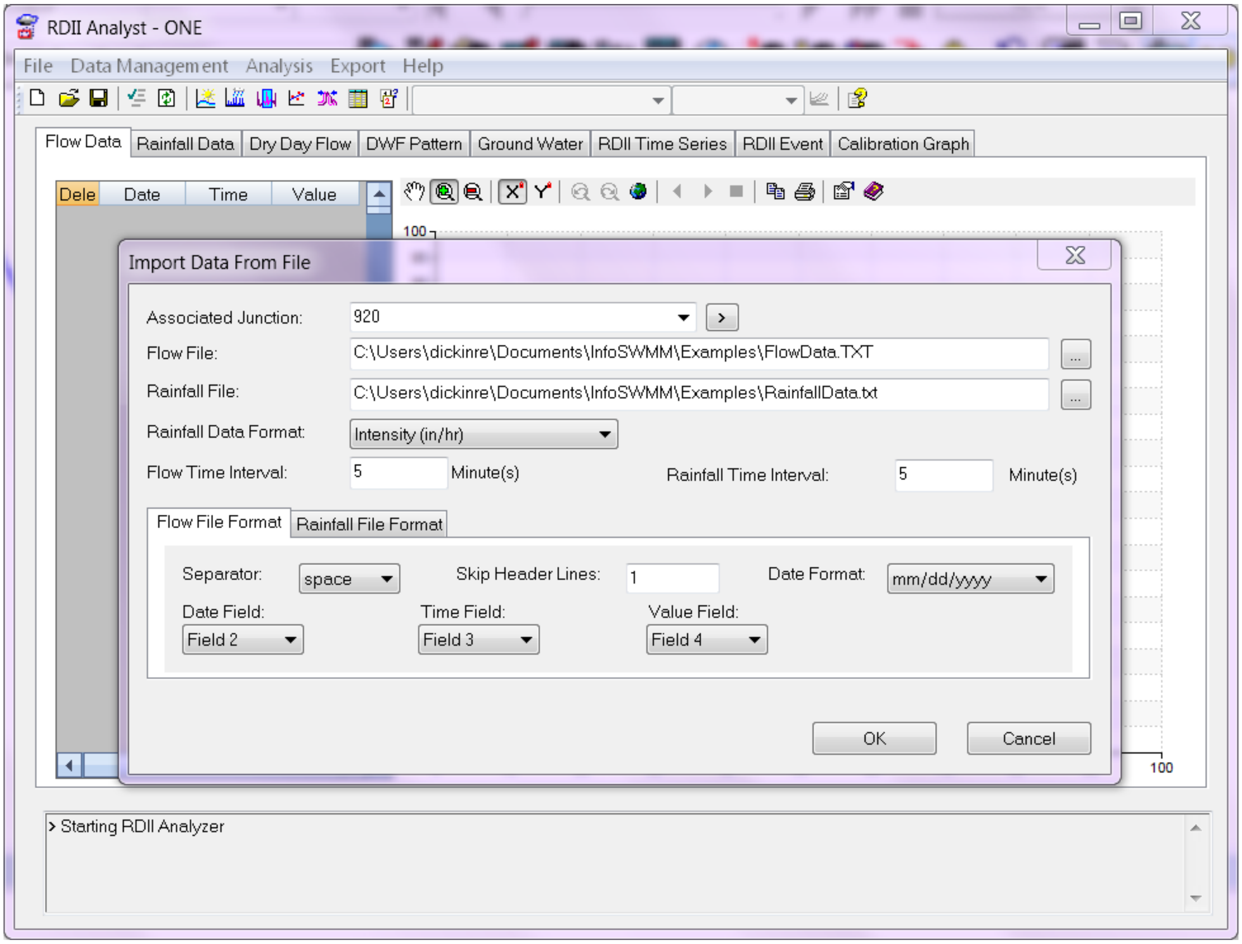
Step 4/3. Specify Flow Monitoring Data and Rainfall Data

1. Create a new analysis by clicking the New button () from the toolbar or the New Menu command

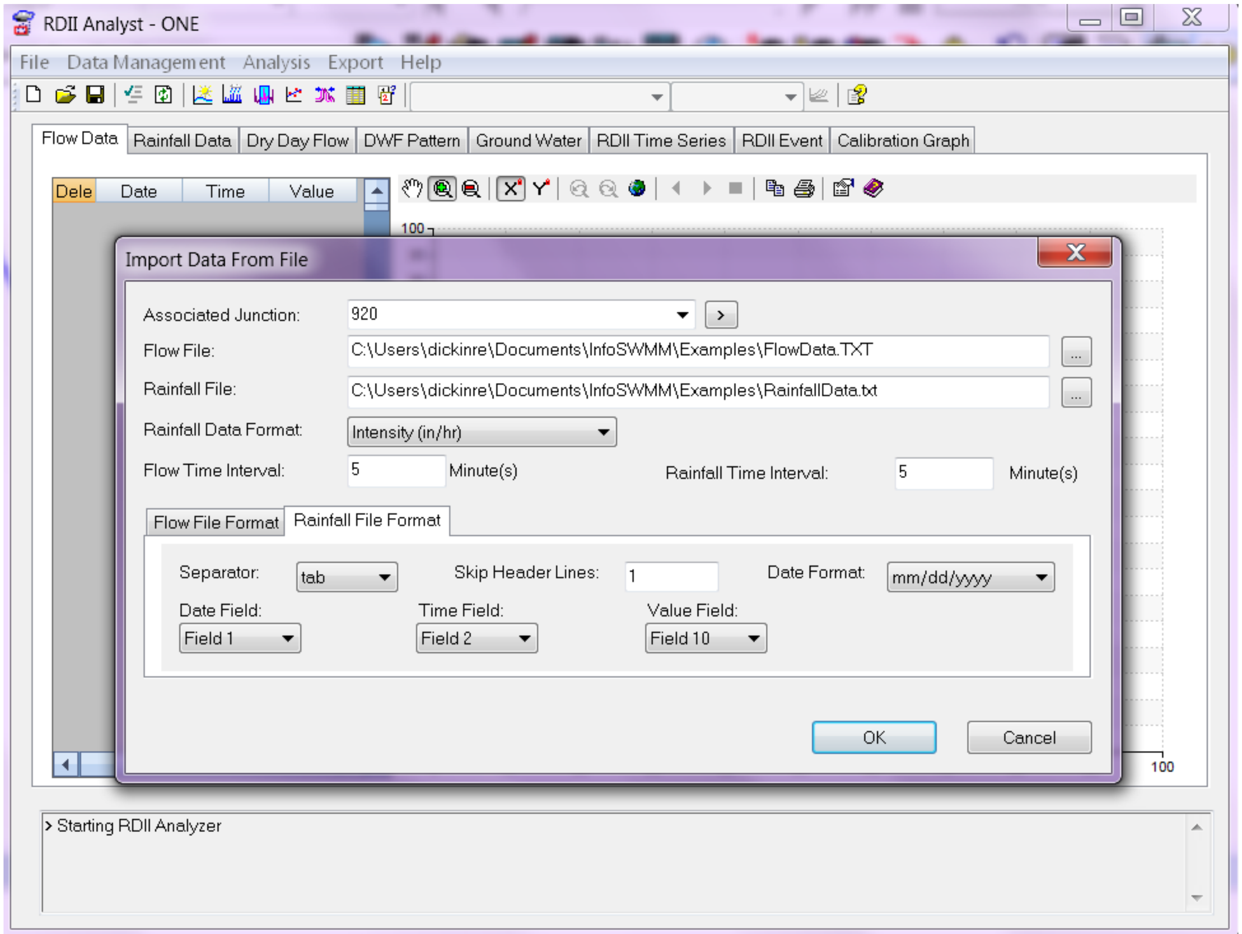
Doing this will launch the New Analysis dialog editor:



2. Import the flow data



3. Import the rainfall data



FIle links for Rainfall and Flow

C:\Users\Public\Documents\InfoSWMM\Examples\FlowData.TXT

C:\Users\Public\Documents\InfoSWMM\Examples\RainfallData.txt

The top of the Flow Data File looks like

SITE DATE HOUR FLOW (cfs)

------ ---------- ---- ----------

MS0350 03/30/1995 23 1.815

MS0350 03/31/1995 0 1.624

The top of the Rain Data File looks like

Year Month Date hour MIN WS1218 WS1209 WS1207 WS1202 WS1206 WS1204 WS1203 WS1216 WS1202

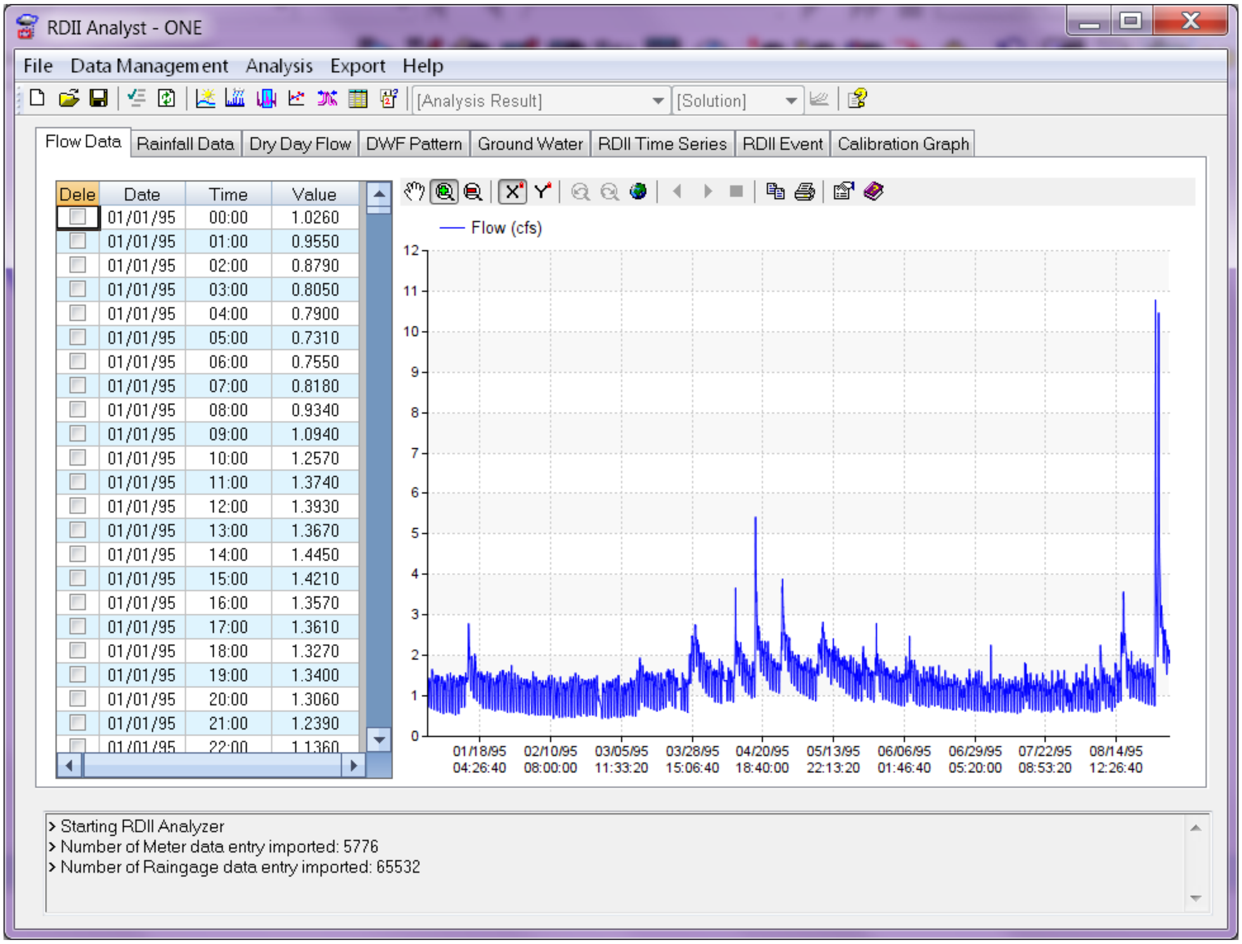
3/31/1995 23:0 1995 3 31 23 0 0 0 0 0 0 0 0 0 0 0 0

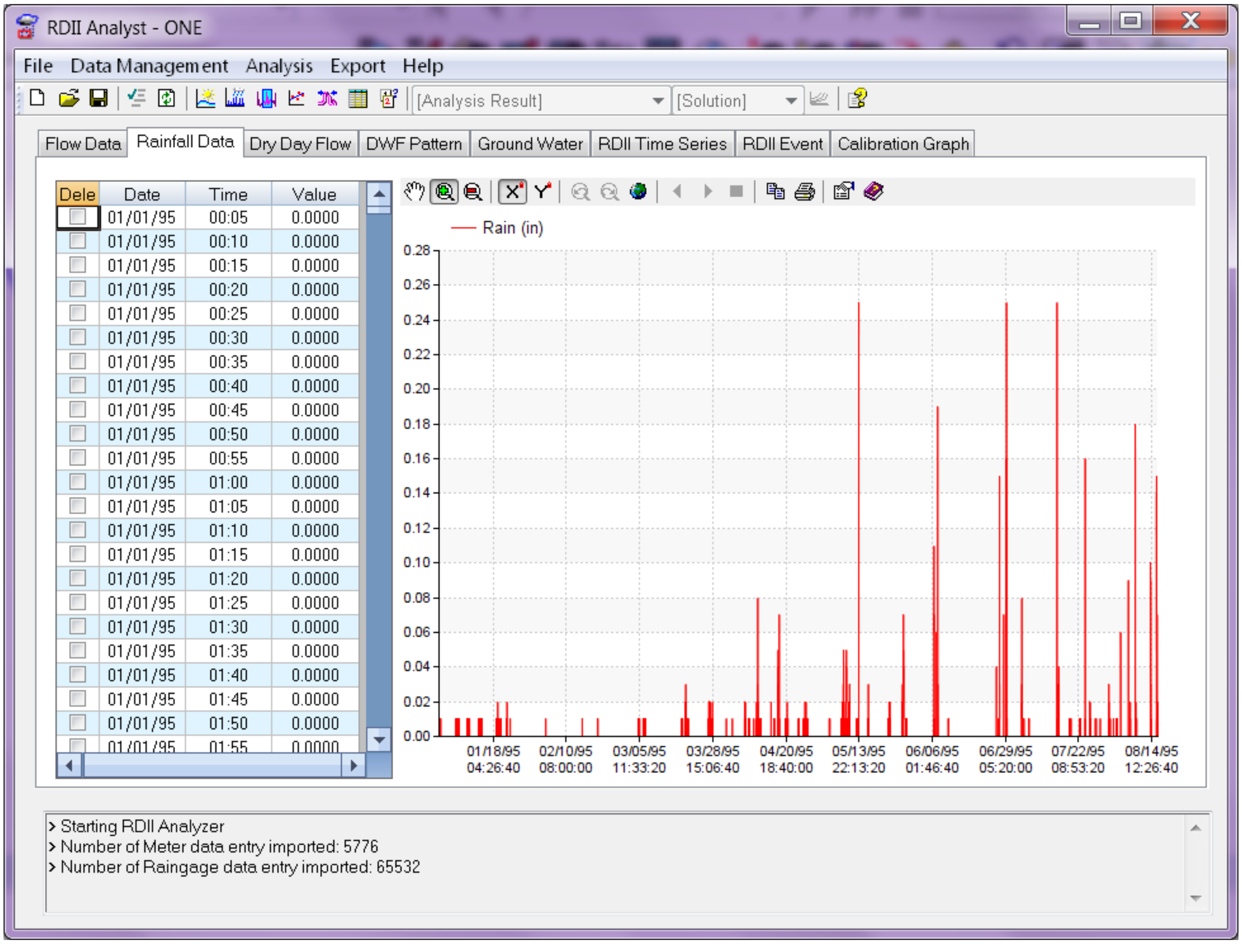
3/31/1995 23:5 1995 3 31 23 5 0 0 0 0 0 0 0 0 0 0 0

4. On the initiated dialog, specify file names for the flow monitoring data and the rainfall data as shown above. The files are available at C:\Users\Public\Documents\InfoSWMM\Examples\

3. Specify all other input information regarding the monitoring site, and format of the flow data (shown above) and the rainfall data (shown below). *Note: If you have previously successfully imported the data then a profile for the Associated Junction will be created. Clicking the Search button ( ) will search for the parameters used on the previous successful import and automatically populate the parameter fields if the profile is found.*

5. Click **OK** and review the data both graphically and in report form.


RDII Analyst - ONE
File Data Management Analysis Export Help
[Analysis Result]
[Solution]
Flow Data
Rainfall Data
Dry Day Flow
DWF Pattern
Ground Water
RDII Time Series
RDII Event
Calibration Graph
Dele Date Time Value
01/01/95 00:00 1.0260
01/01/95 01:00 0.9550
01/01/95 02:00 0.8790
01/01/95 03:00 0.8050
01/01/95 04:00 0.7900
01/01/95 05:00 0.7310
01/01/95 06:00 0.7550
01/01/95 07:00 0.8180
01/01/95 08:00 0.9340
01/01/95 09:00 1.0940
01/01/95 10:00 1.2570
01/01/95 11:00 1.3740
01/01/95 12:00 1.3930
01/01/95 13:00 1.3670
01/01/95 14:00 1.4450
01/01/95 15:00 1.4210
01/01/95 16:00 1.3570
01/01/95 17:00 1.3610
01/01/95 18:00 1.3270
01/01/95 19:00 1.3400
01/01/95 20:00 1.3060
01/01/95 21:00 1.2390
01/01/95 22:00 1.1360
Flow (cfs)
12
11
10
9
8
7
6
5
4
3
2
1
0
01/18/95 04:26:40
02/10/95 08:00:00
03/05/95 11:33:20
03/28/95 15:06:40
04/20/95 18:40:00
05/13/95 22:13:20
06/06/95 01:46:40
06/29/95 05:20:00
07/22/95 08:53:20
08/14/95 12:26:40
> Starting RDII Analyzer
> Number of Meter data entry imported: 5776
> Number of Raingage data entry imported: 65532



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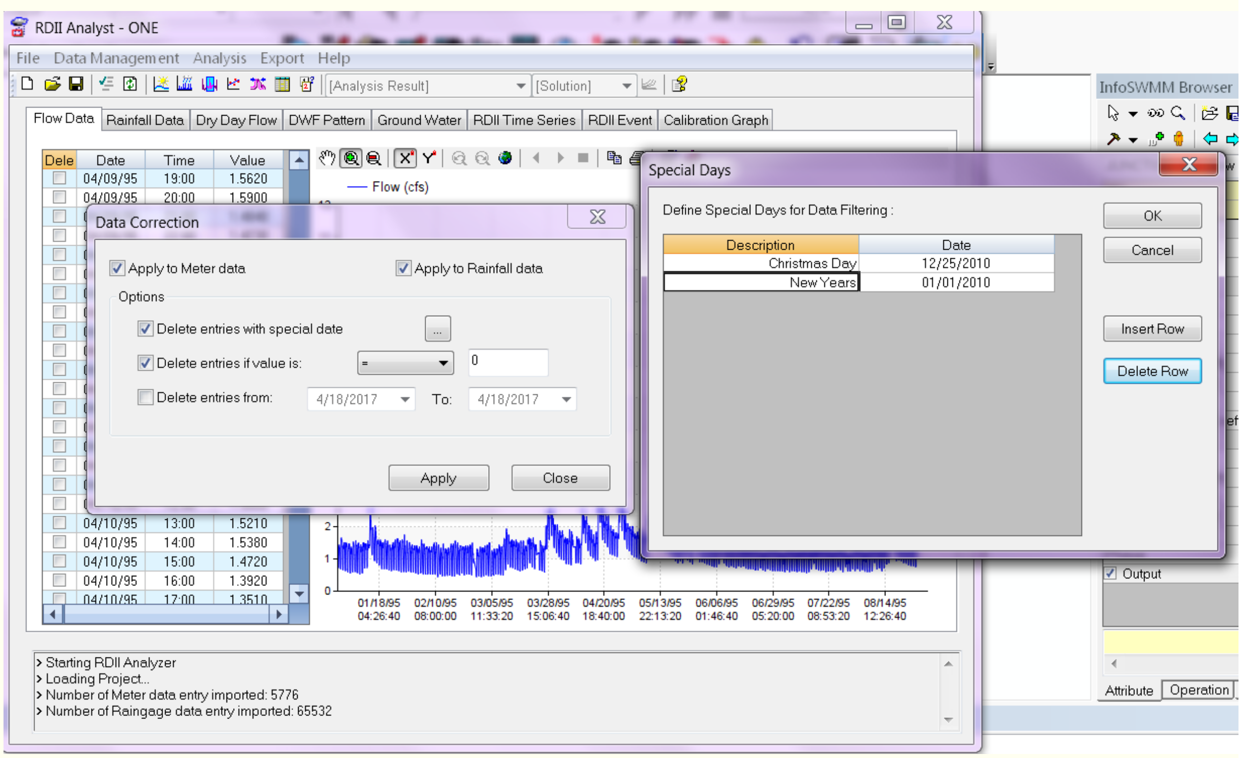
Step 4/4. QA/QC of the Flow Monitoring and Rainfall Data

RDII Analyst allows you to edit the flow data and the rainfall data. You can delete or change some of the suspicious data that are outliers. You can also remove data for non-representative days such as holidays from the analysis. You can manually edit data from the *Value*

column of the desired row(s) and save the changes using the Save () tool on the toolbar. In this tutorial, you will remove data values corresponding to a New Year day (i.e., 01/01/1995) and Independence Day (i.e., 07/04/1995).

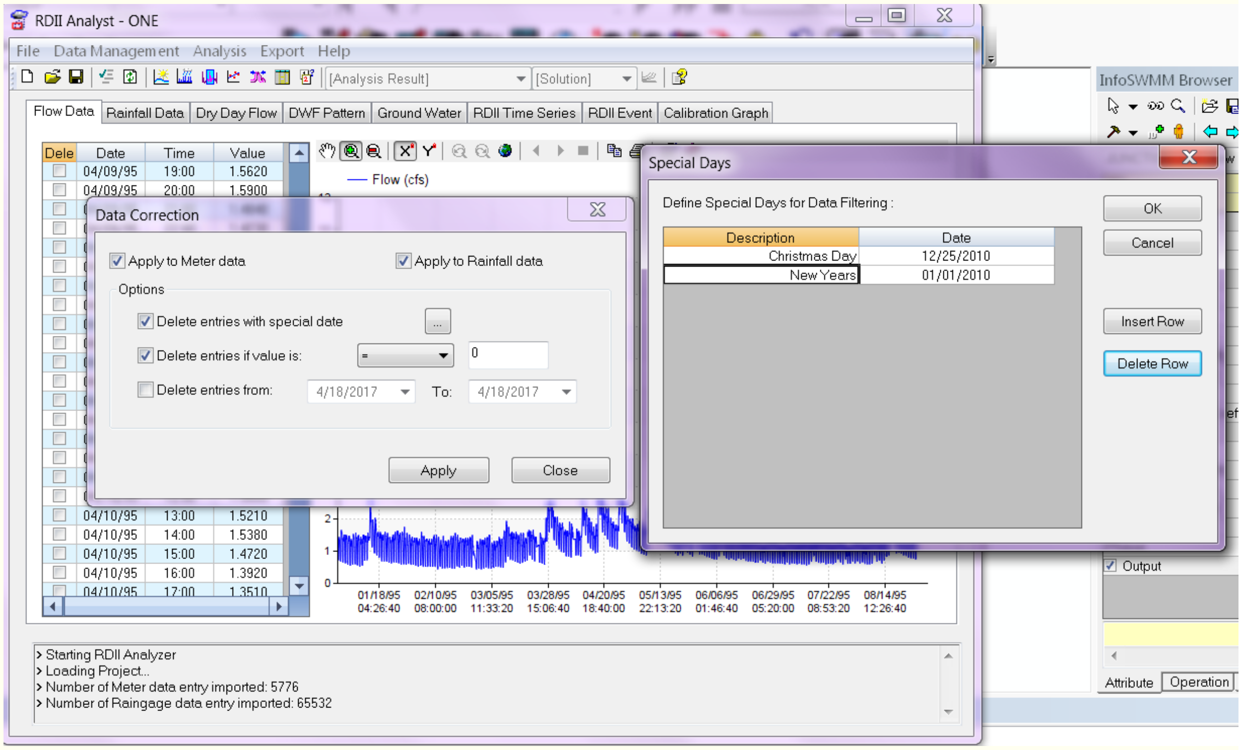
1. From

the menu, click *Data Management -> Data Correction*. On the initiated *Data Correction* editor, select the options as shown below.



2. Click

the Browse button (...) to open a list of Special Days to remove from the data. New days can be copied and pasted from Windows Clipboard.



3. Click

OK. Then click Apply

to remove the flow data corresponding to the listed holidays.

4. Review

the results to verify that the flow monitoring data for the two days are removed from the list.

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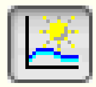
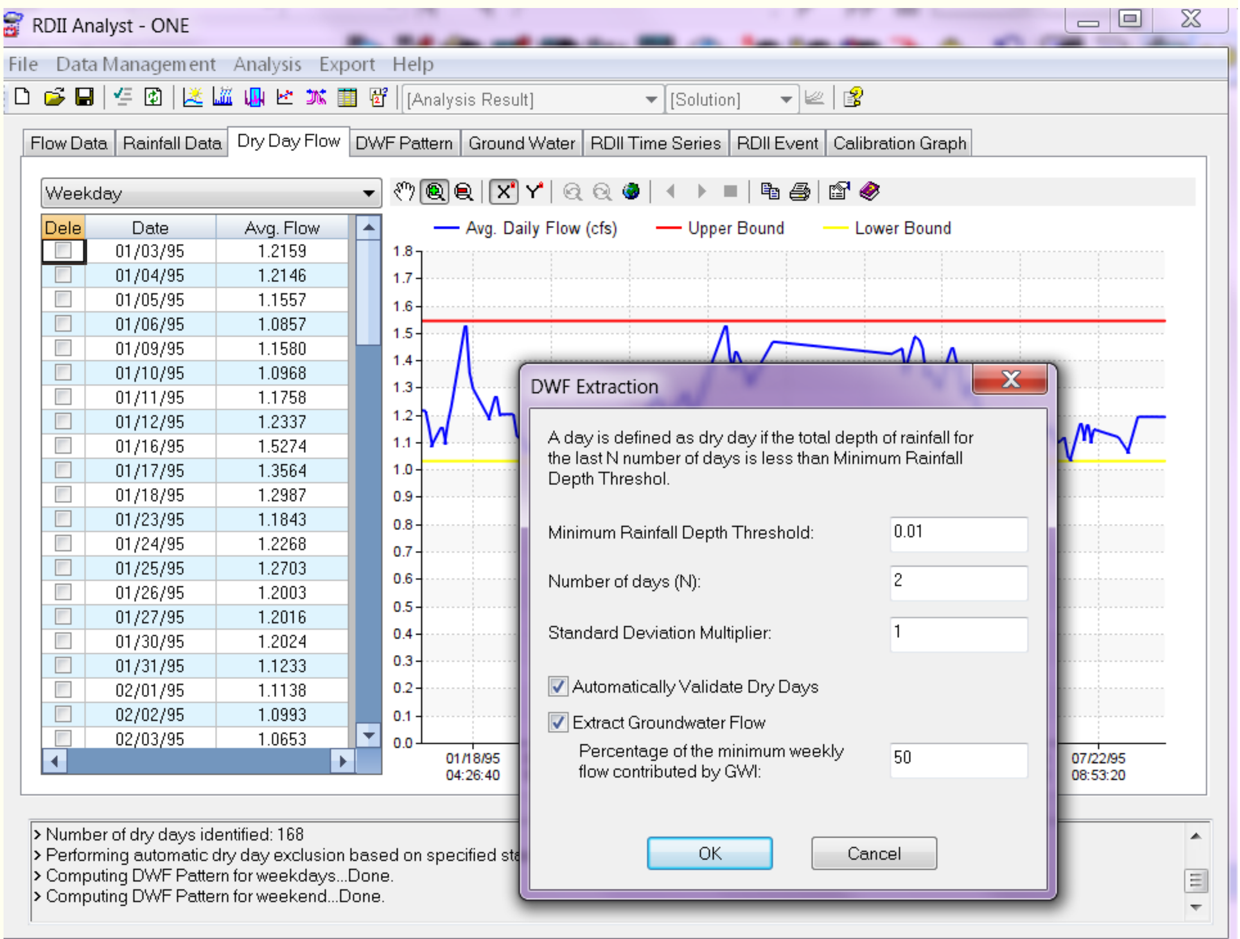
Step 4/5. Determine the Dry Days, Groundwater Flow and DWF Patterns

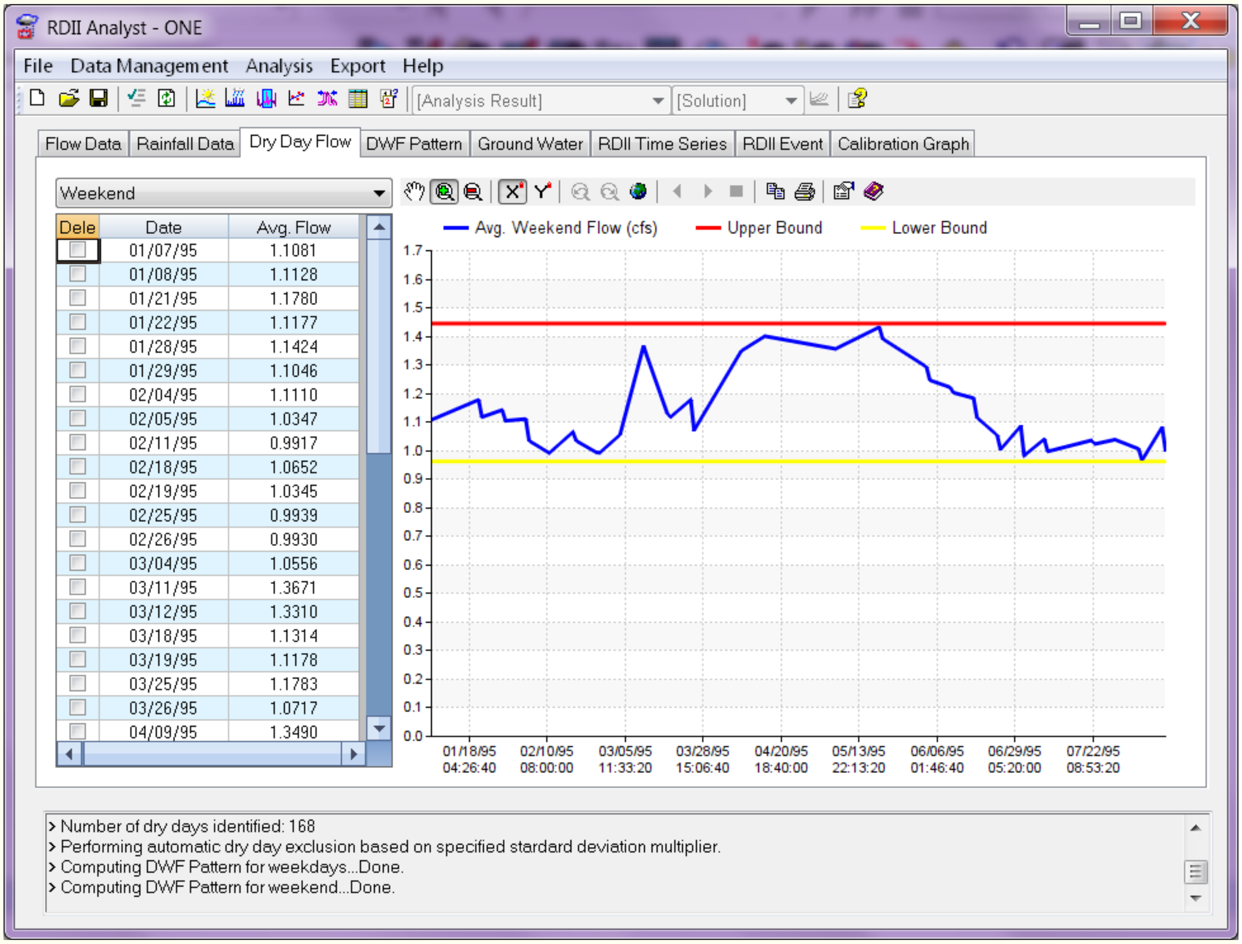
To decompose the flow monitoring data into dry weather flows and wet weather flows, RDII Analyst first identifies the dry days based on user specified criteria.

1. Launch

the *DWF Extraction* dialog by clicking () from the toolbar or from the menu select *Analysis -> Extract DWF*.



[



2. Specify

the values shown above for the Minimum Rainfall Depth Threshold, Number of Days and the Standard Deviation Multiplier and click the OK button.

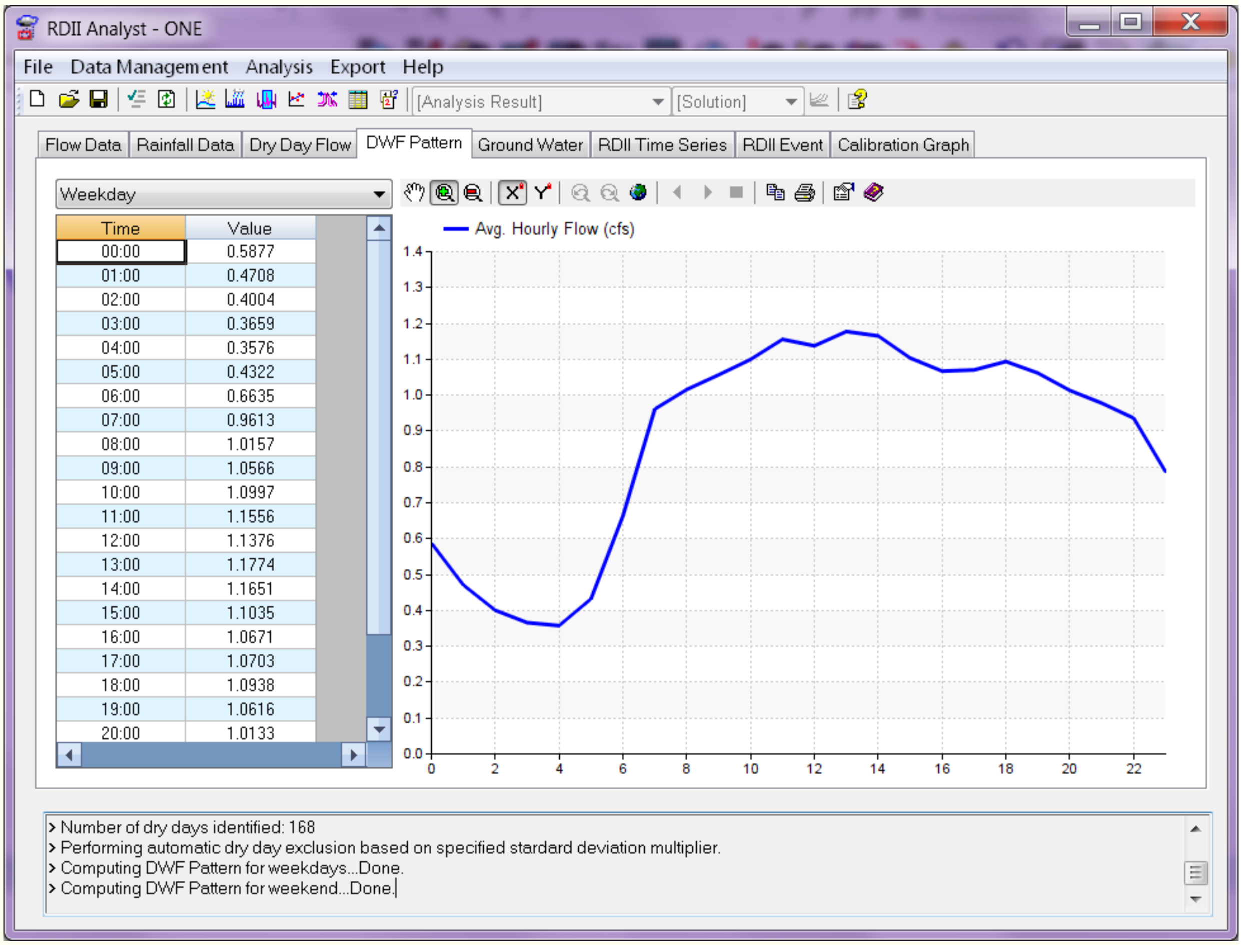
3. The

days that satisfy the dry day criteria specified above would be extracted from the flow monitoring data and would be reported along with average daily flow. In addition, mean daily flow and standard deviation of the identified dry days is calculated and the upper bound and the lower bound lines would be given in graph form. The upper bound line refers to the mean daily flow of the dry days plus *Standard Deviation Multiplier**

standard deviation of the dry day flows. The lower bound line refers to the mean daily flow of the dry days minus *Standard Deviation Multiplier** standard deviation of the dry day flows. If average daily flow for one or more of the dry days is outside the upper bound and the lower bound range, it is likely that the day is an outlier and may have to be discarded from the dry days list and should not be considered for further analysis.

Weekday

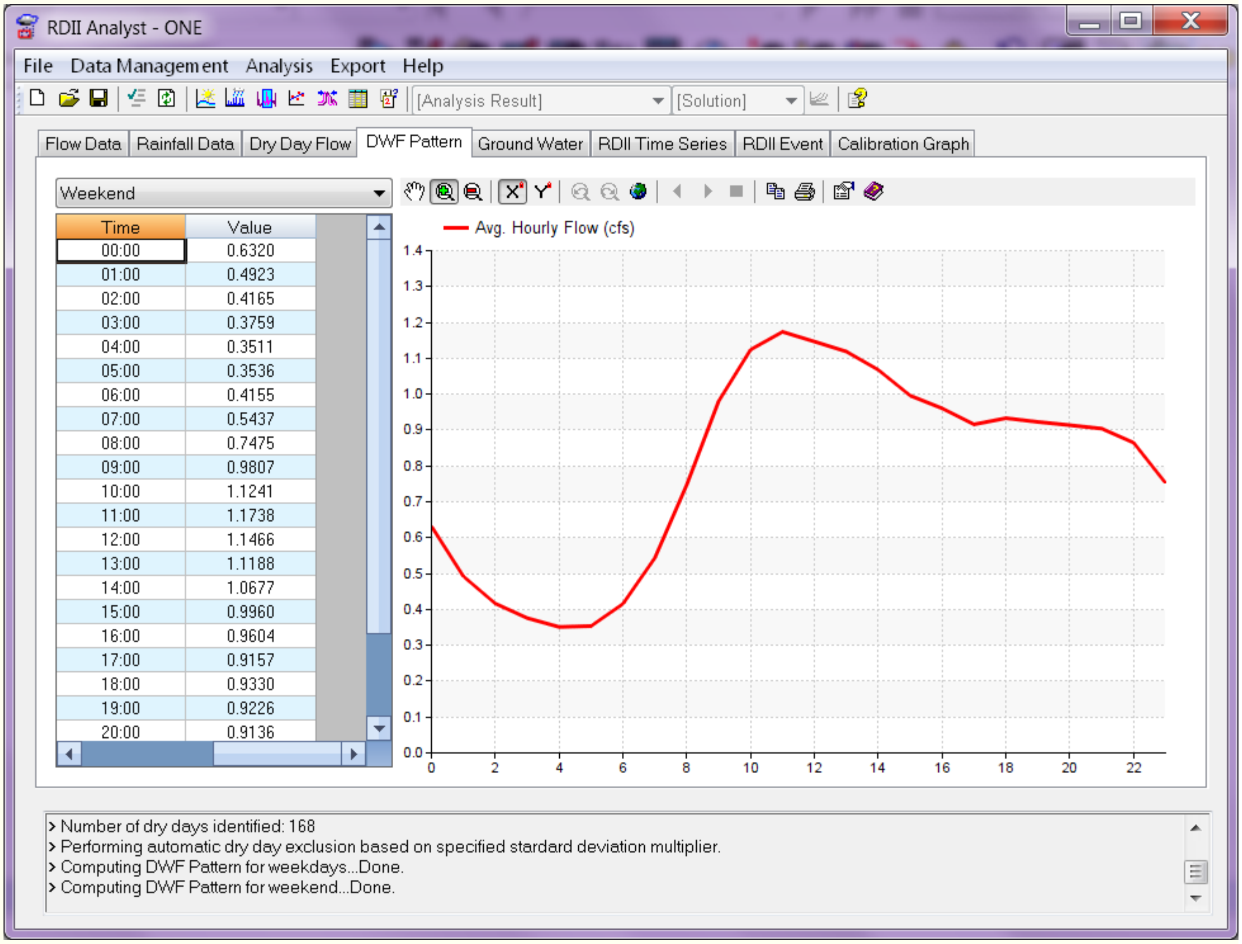
Pattern



4. The

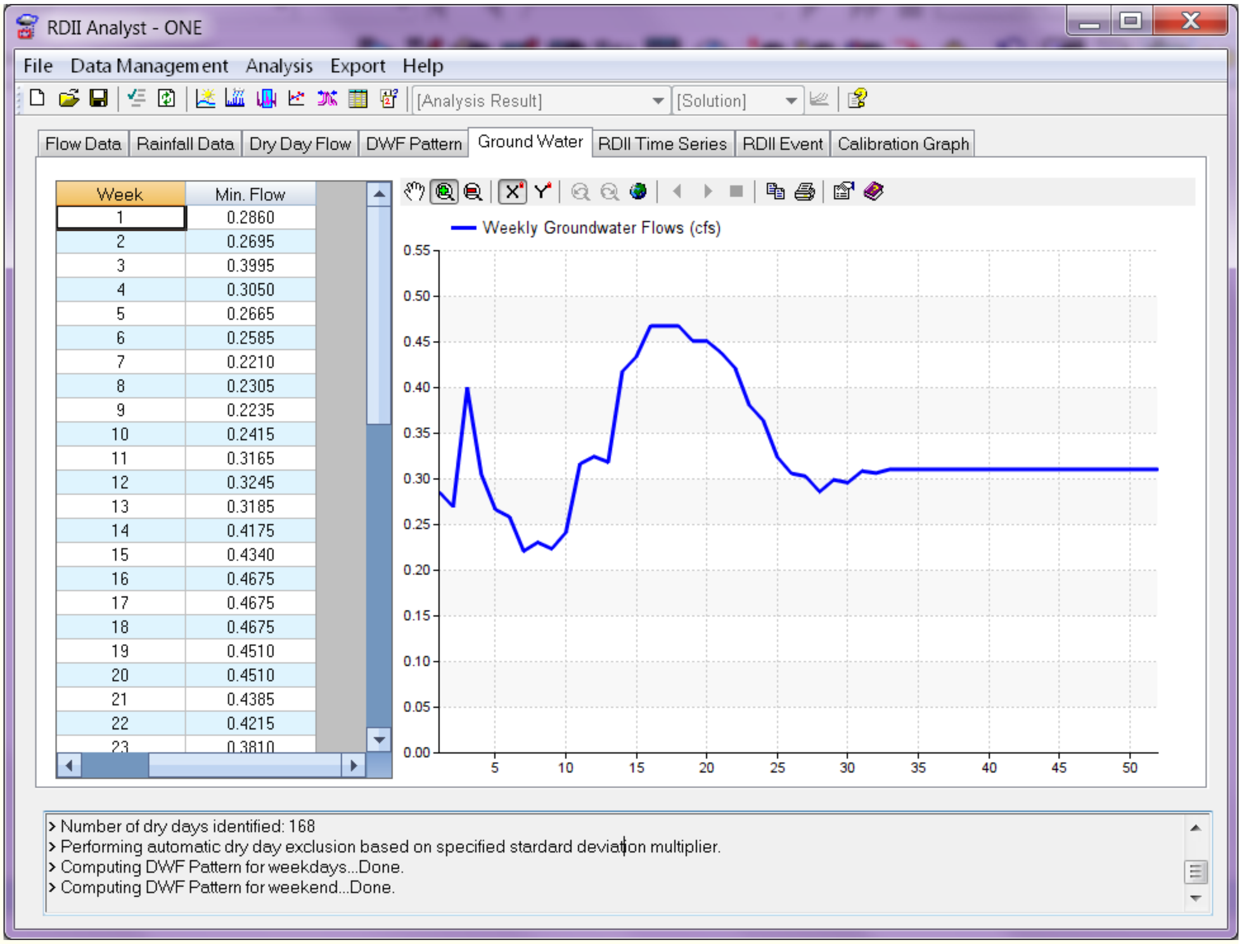
outliers may be deleted manually or automatically. If you wish to delete the outliers automatically, you need to select the **Automatically Validated Dry Days** option and re-run the DWF extraction. To delete the outliers manually, select the outlier data rows with average daily flows outside the bounds as shown below. Click **Delete** at the top of the first column on the report and then click the Save Button (), and click **Yes** at the confirmation message.

Weekend Pattern



5. Groundwater

Flow in the Groundwater Tab



6. *RDII Analyst* can also estimate the groundwater flow contribution to the wastewater flow. Select the **Extract Groundwater Flow** option on the DWF Extraction dialog and specify 0.5 for the **Fraction of the minimum weekly flow contributed by GWI** parameter. *The groundwater flow is estimated as a multiple of the minimum weekly flows observed from the dry days. The minimum weekly flows can be rescaled by this user specified multiplier.*

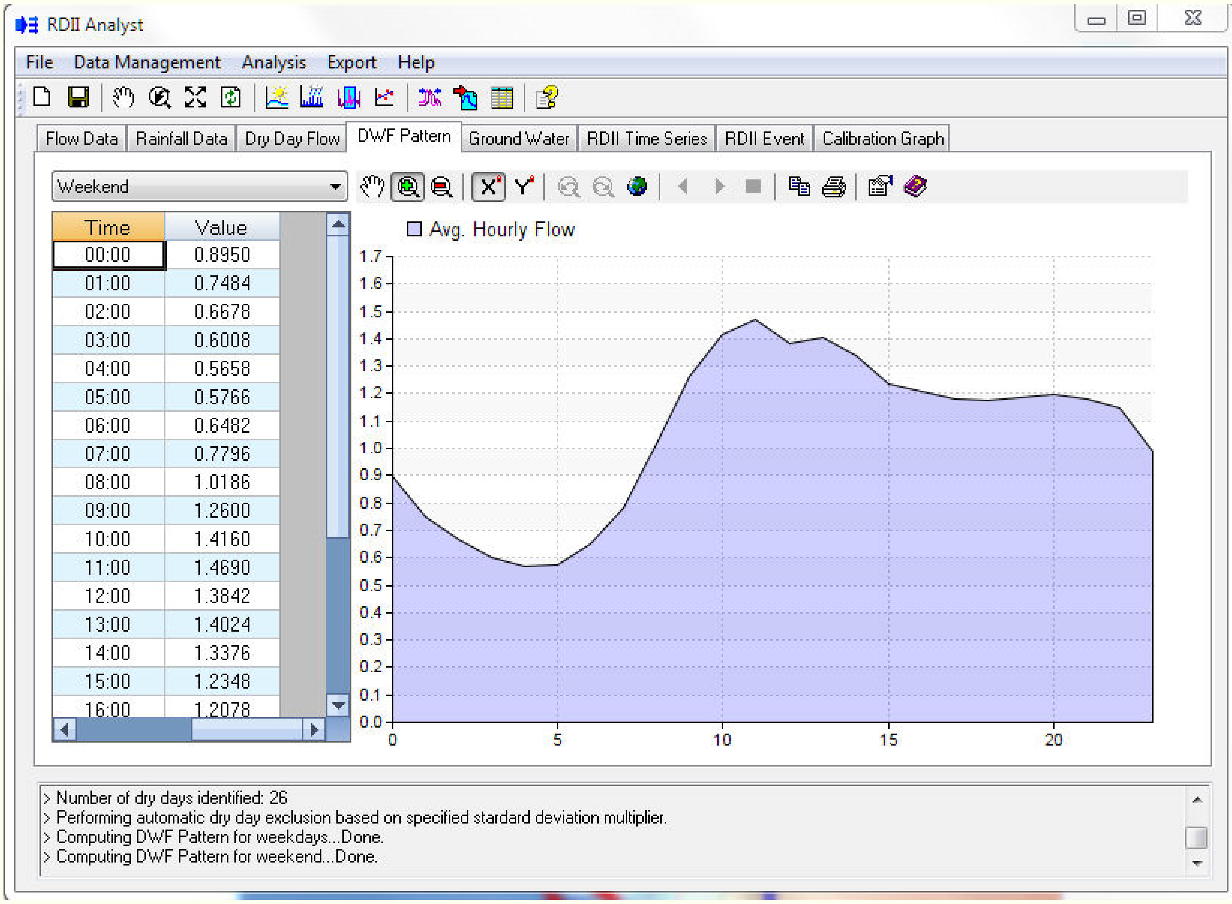
7. Review

the extracted groundwater time series. It has 52 values, one value for each week of the year.

8. Once

the dry days are identified, *RDII Analyst* automatically calculates hourly DWF patterns for weekends and weekdays and presents them both graphically and in report form. To view the hourly DWF patterns, click the **DWF**

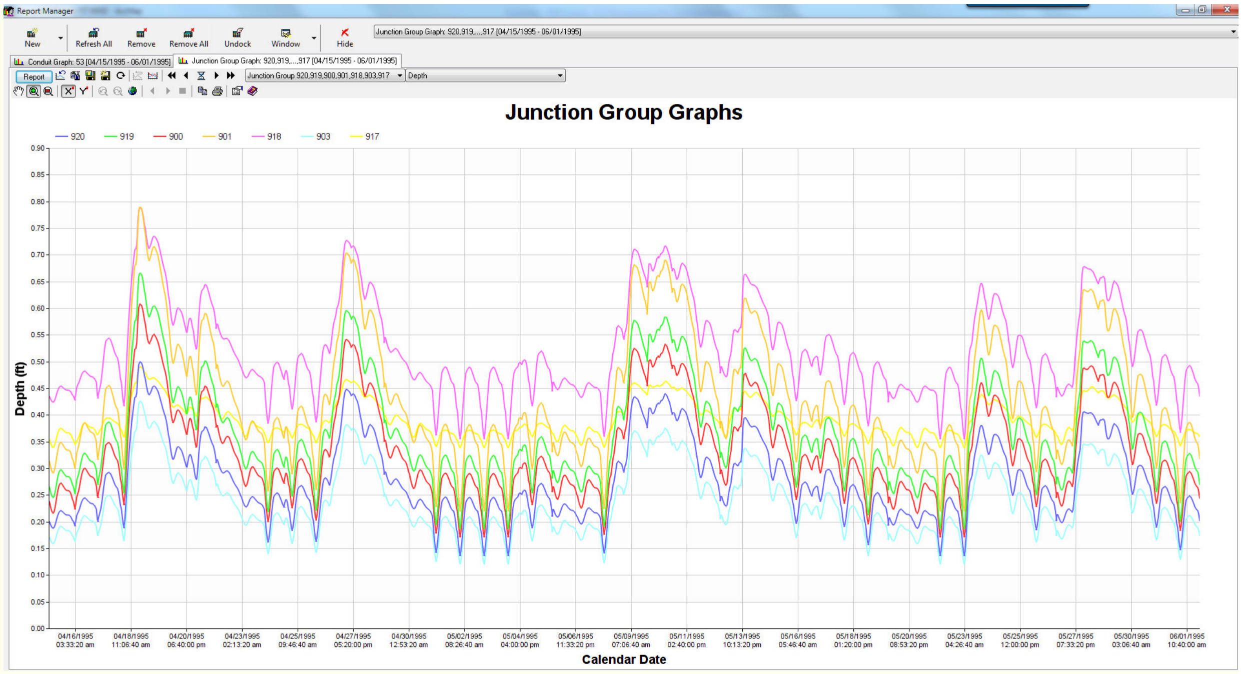
Pattern tab from the graphs and reports list.



9. You can see the DWF Pattern if

you run InfoSWMM and

graph the Lateral Inflow at the Nodes.



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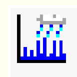
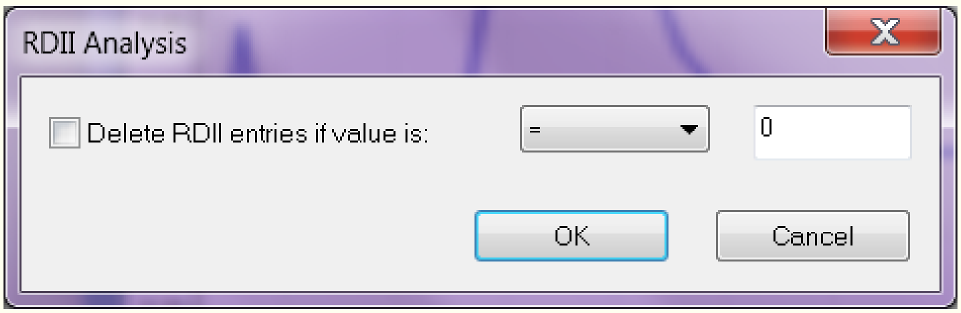
Step 4/6. Determine the RDII Flow Component

RDII flow would be determined by subtracting the DWF and the groundwater flow components identified by the *RDII Analyst* from the corrected flow monitoring data.

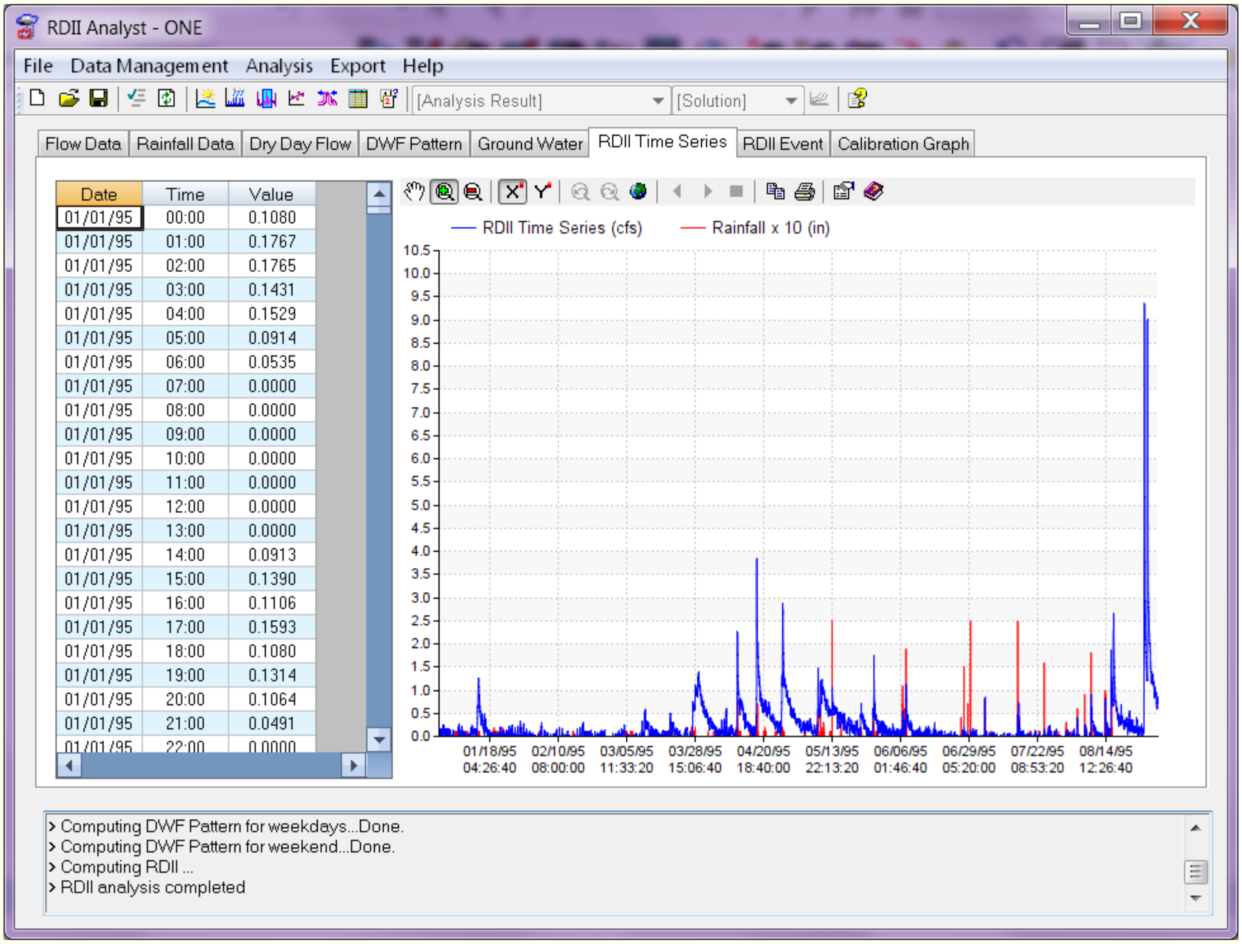
1. To

determine the RDII time series, click the () button on the toolbar, or engage the tool from the menu *Analysis* -> *RDII Analysis* -> *Compute RDII Time Series*. Choose the parameters below.



2. The

RDII time series is provided in graph form and in report format. The RDII time series and the rainfall data are combined for easy visualization of the RDII events and to verify accuracy of the analysis results.



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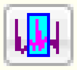
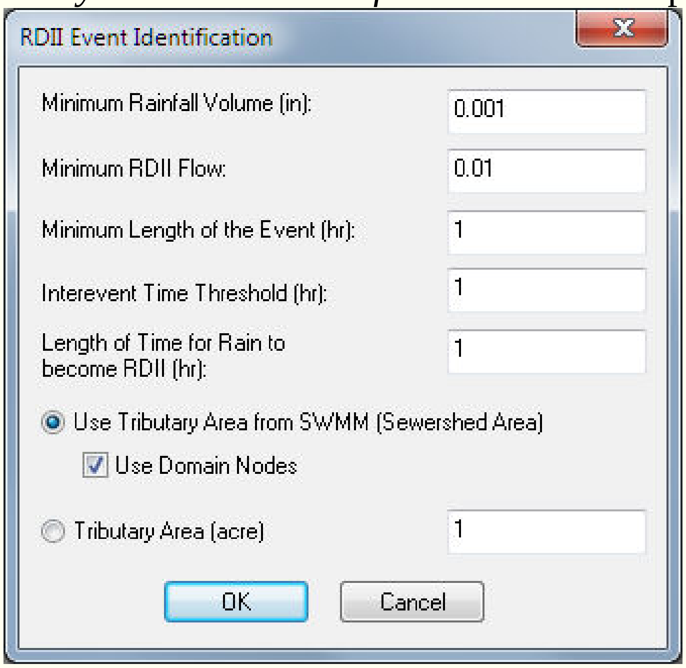
Step 4/7. Determine RDII Events

The RDII time series can be further analyzed to determine RDII events and to summarize each event.

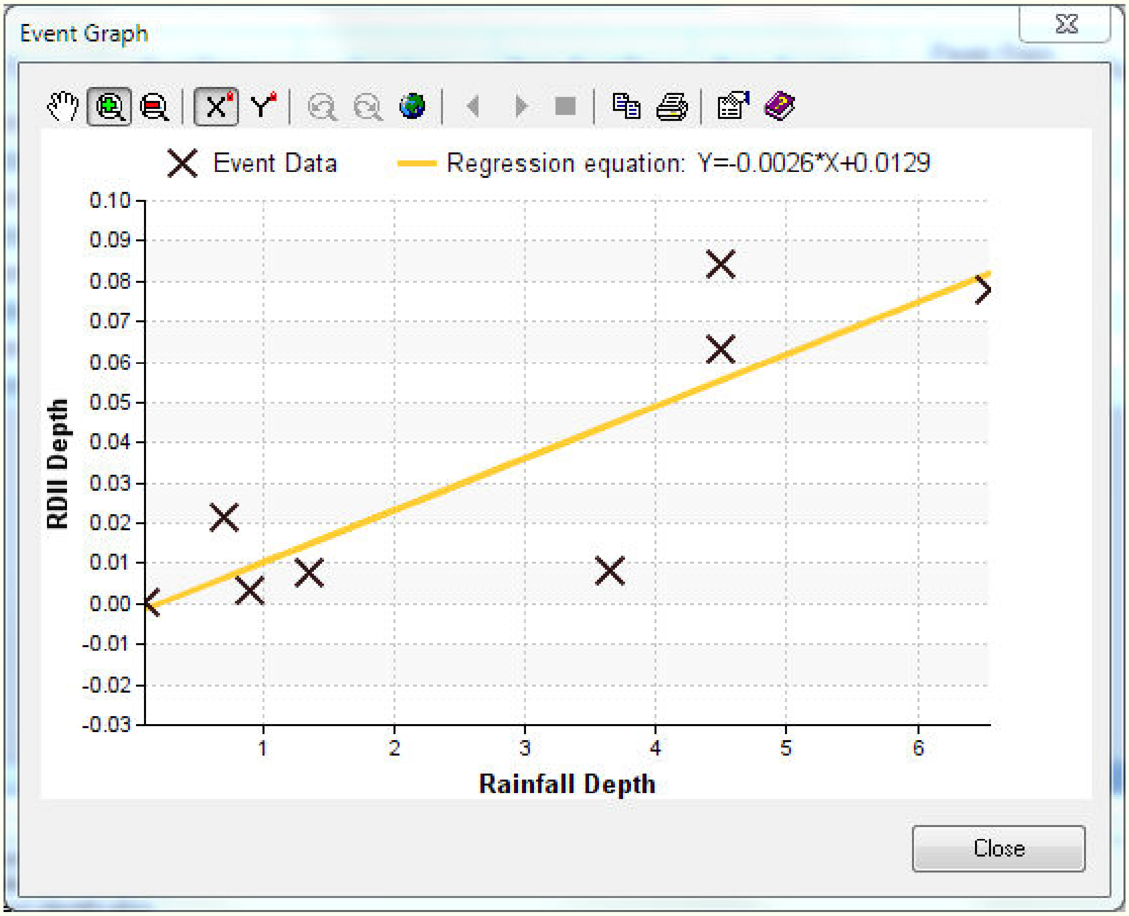
1. Click

the () button from the toolbar, or from the menu *Analysis -> RDII Analyst -> Event Identification*. Enter the parameter values as shown below.



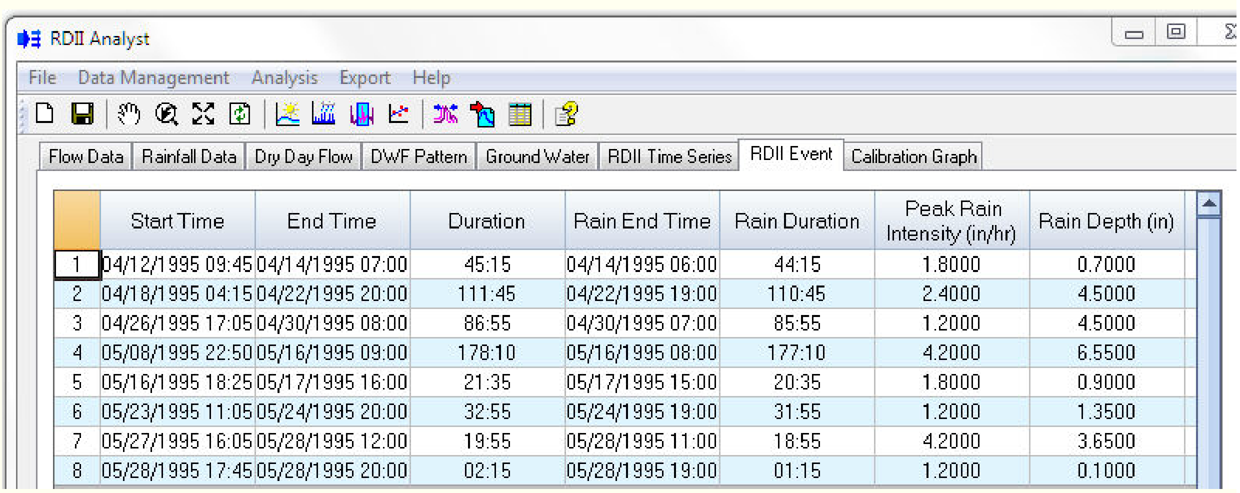
2. Click

. A linear regression equation that describes RDII volume as a function of rainfall depth for the RDII events would be developed. The linear regression result and summary of each RDII event would be reported as shown below.



3. The

RDII Event Identification Table



	Start Time	End Time	Duration	Rain End Time	Rain Duration	Peak Rain Intensity (in/hr)	Rain Depth (in)
1	04/12/1995 09:45	04/14/1995 07:00	45:15	04/14/1995 06:00	44:15	1.8000	0.7000
2	04/18/1995 04:15	04/22/1995 20:00	111:45	04/22/1995 19:00	110:45	2.4000	4.5000
3	04/26/1995 17:05	04/30/1995 08:00	86:55	04/30/1995 07:00	85:55	1.2000	4.5000
4	05/08/1995 22:50	05/16/1995 09:00	178:10	05/16/1995 08:00	177:10	4.2000	6.5500
5	05/16/1995 18:25	05/17/1995 16:00	21:35	05/17/1995 15:00	20:35	1.8000	0.9000
6	05/23/1995 11:05	05/24/1995 20:00	32:55	05/24/1995 19:00	31:55	1.2000	1.3500
7	05/27/1995 16:05	05/28/1995 12:00	19:55	05/28/1995 11:00	18:55	4.2000	3.6500
8	05/28/1995 17:45	05/28/1995 20:00	02:15	05/28/1995 19:00	01:15	1.2000	0.1000

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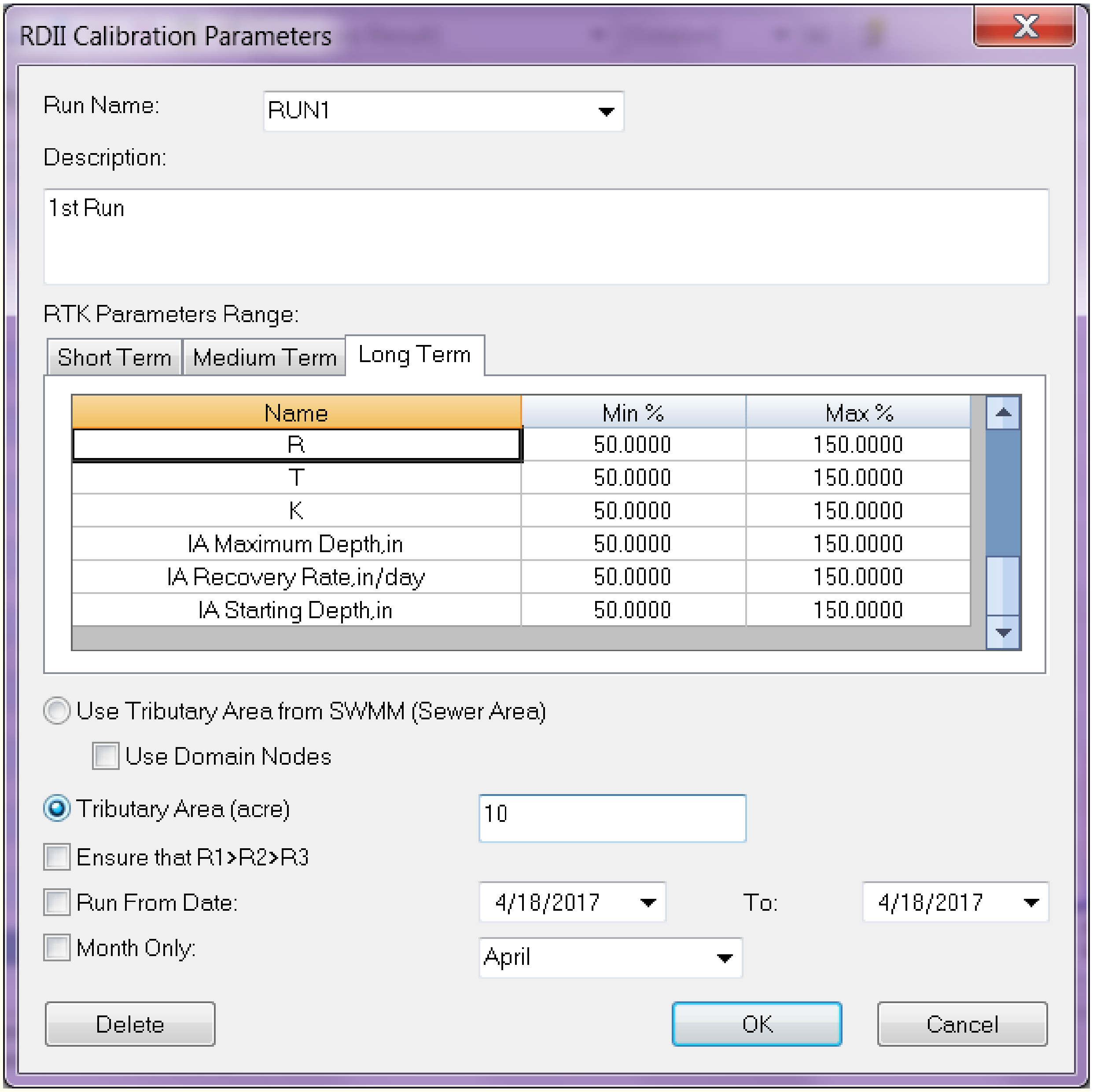
Step 4/8. Calibrate the RTK Hydrograph Parameters

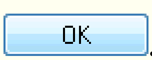
Automated calibration is another powerful tool that *RDII Analyst* offers. The calibration tool identifies optimal parameters of the RTK hydrograph to match the RDII flow simulated by H2OMAP SWMM with the RDII time series identified by *RDII Analyst* using the decomposition process described previously. The RTK parameters that can be calibrated may be selected by the user from the 12 parameters available to choose from.

1. You

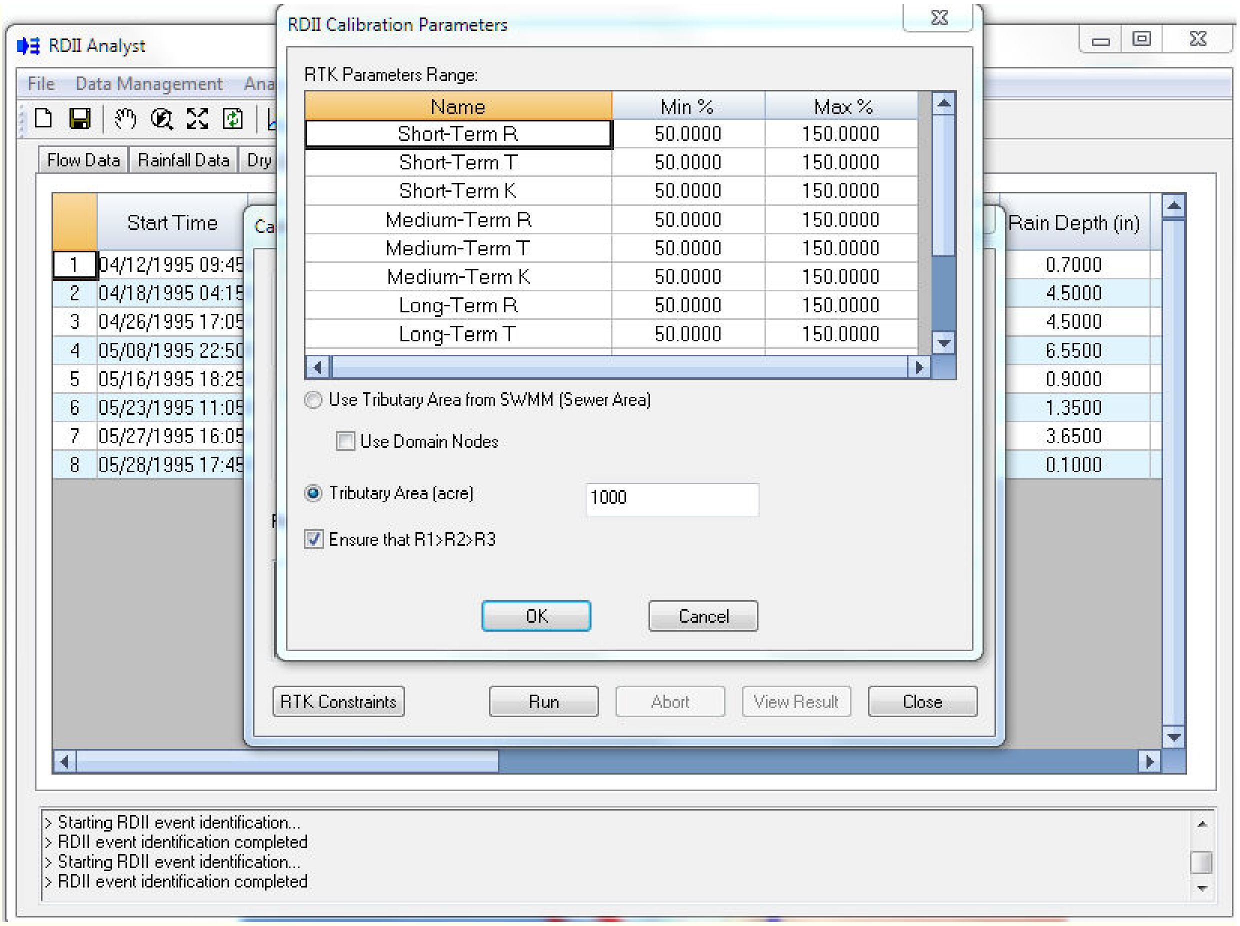
may initiate the *RDII Calibration Parameters* page by clicking the () button from the toolbar or from the menu *Analysis -> Calibrate RDII Parameters*. Specify the minimum and the maximum ranges shown below for each parameter.



2. Click

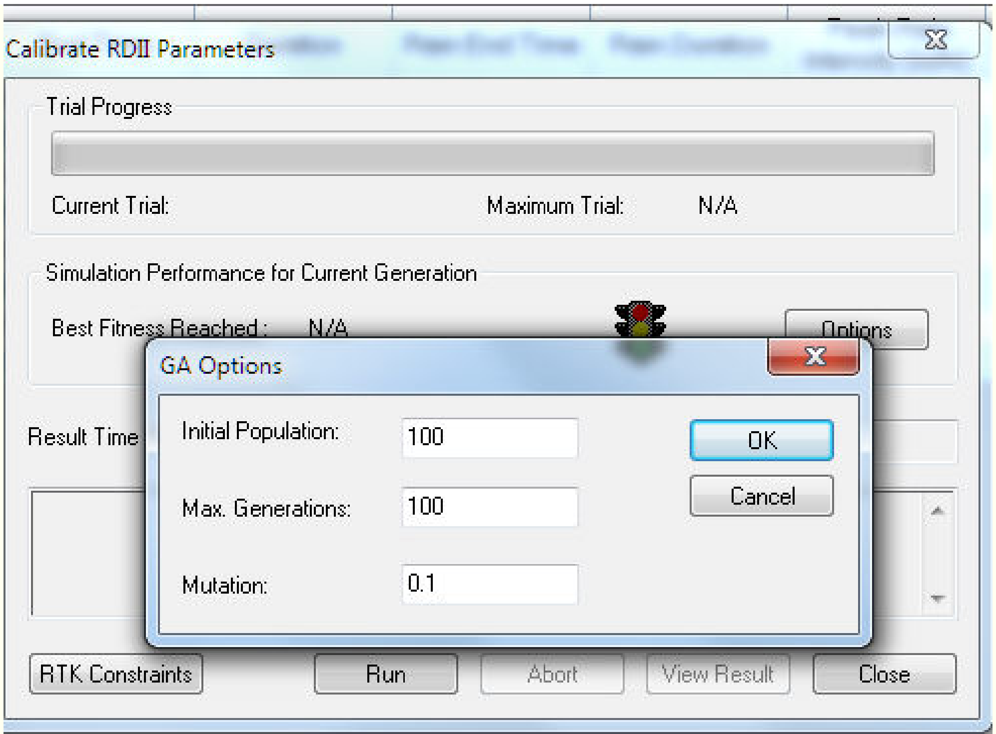


. The *Calibrate RDII Parameters* dialog editor would be initiated.



3. Click

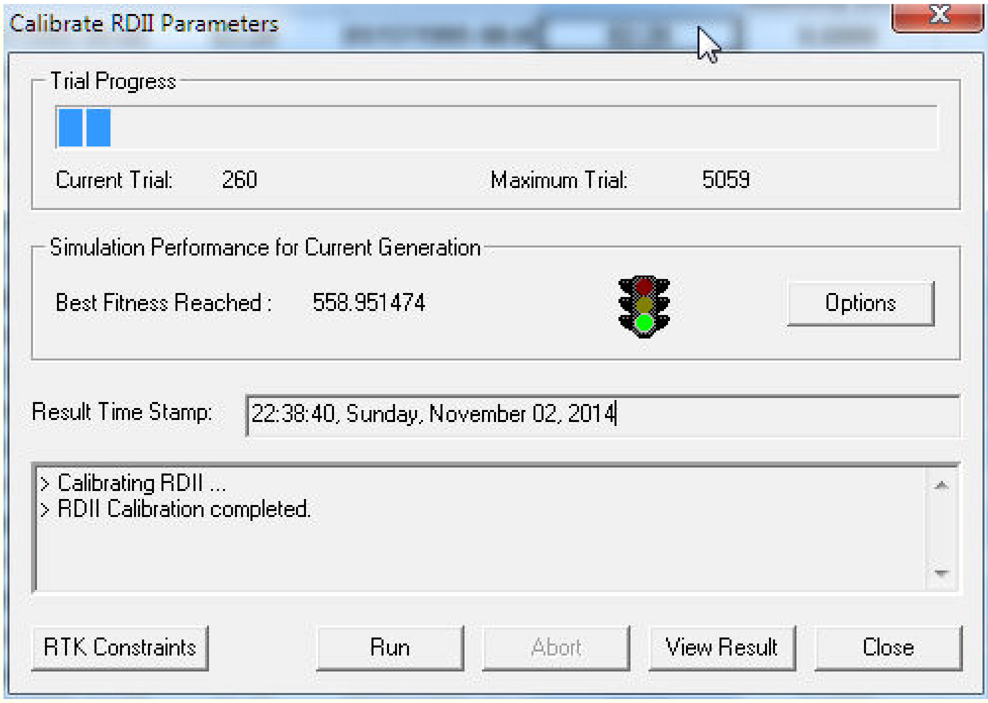
the **Options** button to adjust the GA Options to match the following.

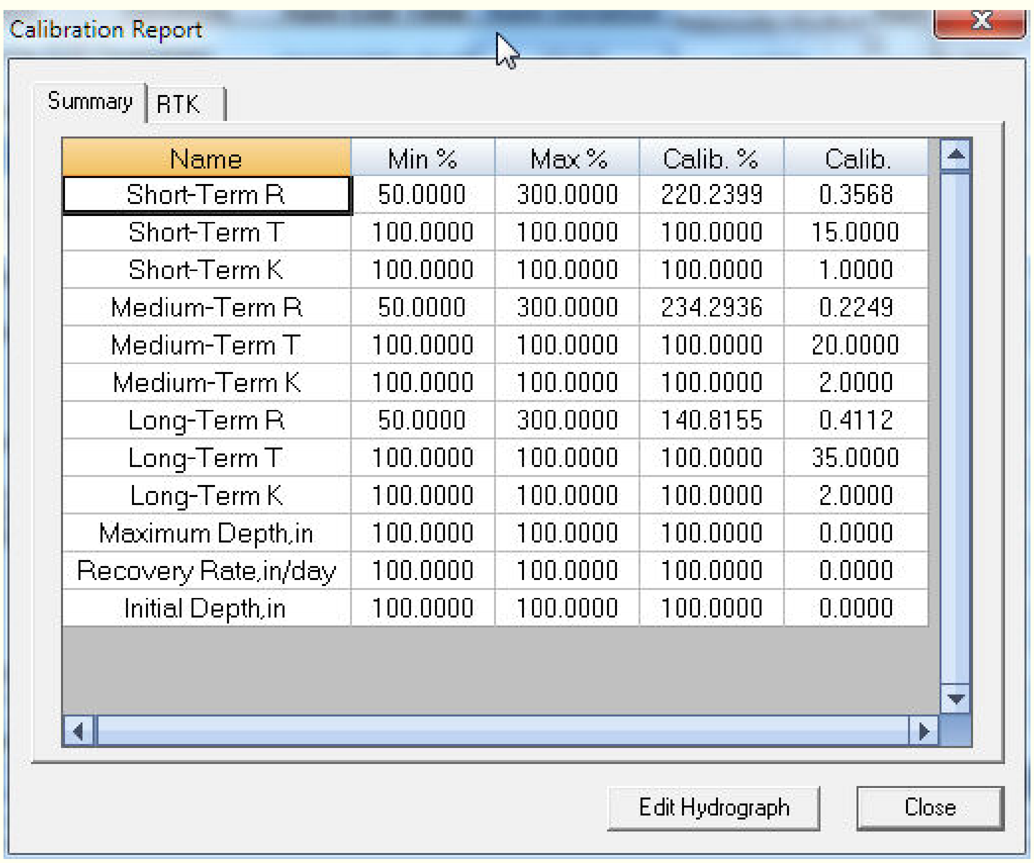


4. Click

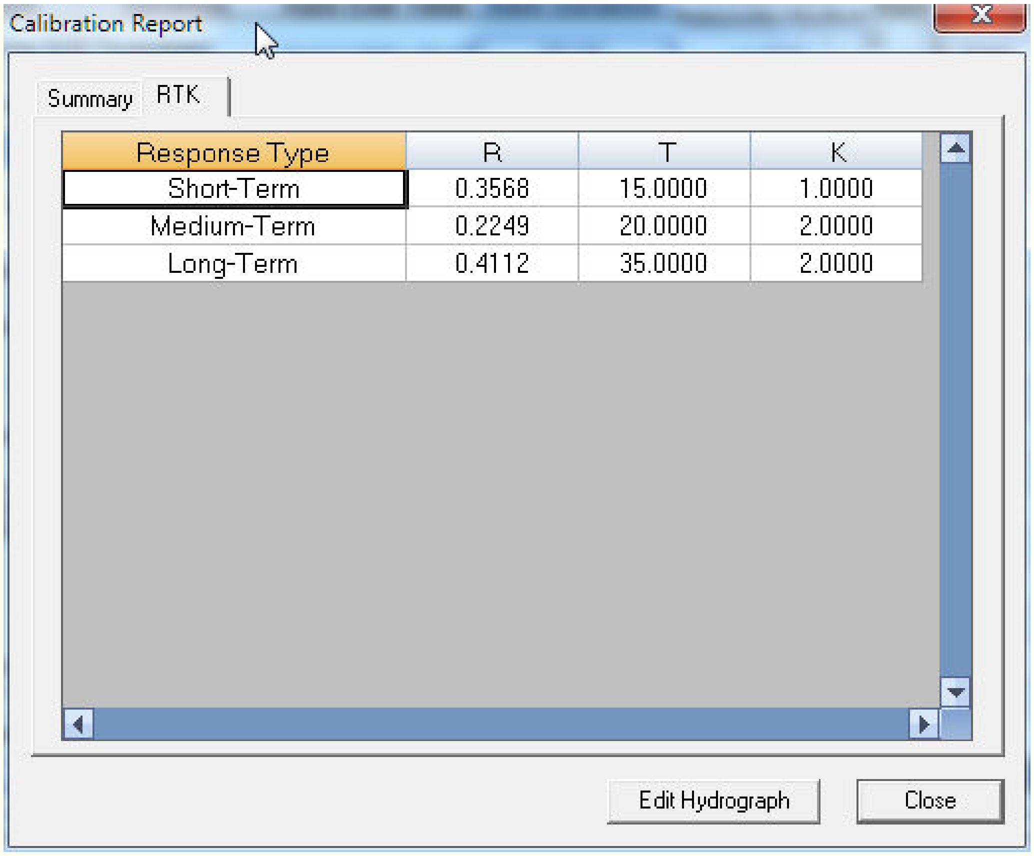
the **Run** button. The number of trial runs made so far, the maximum number of trials to be made and the best fitness obtained from the trail runs made so far would be shown while the model is running.

If there is no significant improvement in the fitness for some time (i.e., from generation to generation), then the calibration process would be stopped. Once the calibration run is completed, the RDII flow simulated by the optimal RTK parameters identified by the calibration process would be compared graphically with the RDII time series obtained from the decomposition process. In addition, the optimal RTK parameters identified by the model would also be presented in report form as shown below.



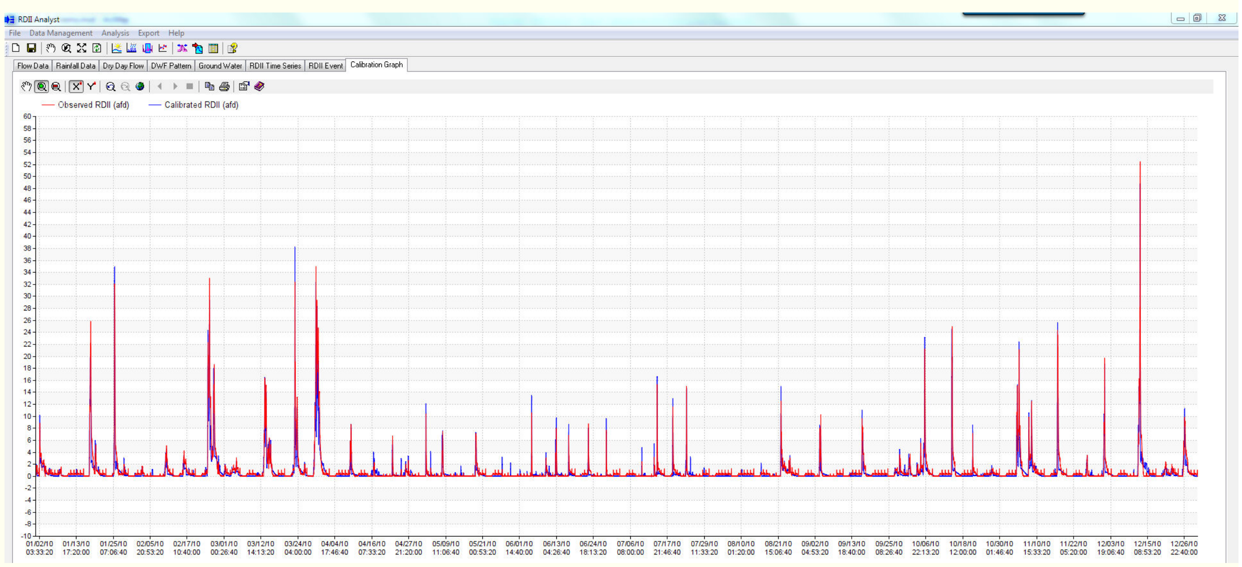


Name	Min %	Max %	Calib. %	Calib.
Short-Term R	50.0000	300.0000	220.2399	0.3568
Short-Term T	100.0000	100.0000	100.0000	15.0000
Short-Term K	100.0000	100.0000	100.0000	1.0000
Medium-Term R	50.0000	300.0000	234.2936	0.2249
Medium-Term T	100.0000	100.0000	100.0000	20.0000
Medium-Term K	100.0000	100.0000	100.0000	2.0000
Long-Term R	50.0000	300.0000	140.8155	0.4112
Long-Term T	100.0000	100.0000	100.0000	35.0000
Long-Term K	100.0000	100.0000	100.0000	2.0000
Maximum Depth,in	100.0000	100.0000	100.0000	0.0000
Recovery Rate,in/day	100.0000	100.0000	100.0000	0.0000
Initial Depth,in	100.0000	100.0000	100.0000	0.0000


Calibration Report
Summary
RTK

Response Type	R	T	K
Short-Term	0.3568	15.0000	1.0000
Medium-Term	0.2249	20.0000	2.0000
Long-Term	0.4112	35.0000	2.0000

Edit Hydrograph
Close


RDII Analyst
File Data Management Analysis Export Help
Flow Data
Rainfall Data
Dry Day Flow
DWF Pattern
Ground Water
RDII Time Series
RDII Event
Calibration Graph
Observed RDII (afd)
Calibrated RDII (afd)

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  SSO evaluations: Filtration and inflow using SWMM RUNOFF and EXTRAN, in Best Modeling Practices for Urban Water Systems, Monograph 10, edited by W. James, pp. 197–214, CHI, Guelph, ON.

- Vallabhaneni, S., C. C. Chan, and E. H. Burgess (2007), Computer Tools for Sanitary Sewer System Capacity Analysis and Planning, Cincinnati, OH.

- Vallabhaneni, S., F. Lai, C. Chan, E. H. Burgess, and R. Field (2008), SSOAP — a USEPA toolbox for SSO analysis and control planning, in World Environmental and Water Resources Congress 2008: Ahupua'a, edited by R. W. Babcock, Jr. and R. Walton, pp. 1–10, ASCE, Reston, VA, doi: 10.1061/40976(316)24.

- Storm Water Management Model Reference Manual Volume I - Hydrology (PDF) (235

  pp, 3.8 MB) January 2016 Revised, EPA No. 600/R-15/162A

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Innovyze Further Expands RDII Analyst Functionality, Setting New Standard for Sanitary and Combined Sewer System Model Calibration

New Features Allow Unprecedented Analysis and Comparison of Rainfall-Derived Inflow and Infiltration Data, Parameters for Complex Sewers

Broomfield, Colorado, USA, March 15, 2016

Innovyze, a leading global innovator of business analytics software and technologies for smart wet infrastructure, today announced the newest release of its *RDII*

Analyst (Rainfall-Derived

Inflow and Infiltration) for *InfoSWMM* and *H2OMAP SWMM*. The new version delivers expanded functionality, incorporating many advanced Genetic Algorithm (GA) optimization features. It increases its unmatched productivity by making it easy for users to further adjust the dry weather flow (DWF) and RTK parameters (with initial and maximum monthly storages for continuous simulation) to achieve a better fit and ultimately a better model based on their experiences. The release confirms Innovyze's commitment to giving the world the most complete toolset for modeling current sanitary and combined sewer collection systems.

Excessive wet weather flow from rainfall-derived manhole and pipe defect inflow and infiltration is a major source of sanitary and combined sewer overflows. Controlling these overflows is vital in reducing risks to public health and protecting the environment from water pollution.

Computer modeling plays an important role in determining sound and economical remedial solutions that reduce RDII; improve system integrity, reliability and performance; and avoid overflows.

The processes for converting rainfall to RDII flow in sanitary sewer systems are very complicated. In addition to rainfall and antecedent moisture conditions, factors controlling RDII responses include depth to groundwater, depth to bedrock, land slope, number and size of sewer system defects, type of storm drainage system, soil characteristics, and type of sewer backfill. Given this degree of complexity, flow-monitoring data must be combined with mathematical modeling and analytics to provide accurate results. The wastewater flow monitoring data obtained by sewer collection systems consists of dry-weather flow components, ground water flow and twelve (12) RDII flow components. A crucial step in successfully modeling sewer collection systems is the ability to decompose flow-monitoring data into RDII flow, ground water flow and dry weather flow and its flow pattern.

Significantly superior to the EPA Sanitary Sewer Overflow Analysis and Planning (SSOAP) program and powered by advanced GA optimization and comprehensive data analytics and scenario management, *RDII Analyst* provides

the ability to quickly and reliably perform these types of advanced flow decomposition data monitoring. It has been updated with tabular comparisons between the observed and calibrated RDII data for each event, including R value, peak flow, hydrograph volume and depth.

This allows the user to better evaluate simulated and monitored data and judge how well it correlates on a per event basis. The user can also directly edit estimated DWF mean values to apply site specific knowledge to the *RDII*

Analyst DWF extraction

algorithm. These altered DWF values can then be used to estimate the wet weather flow component of the monitored flow, using a combination of the DWF extraction algorithm and site-specific knowledge. The new version also allows direct edits to the twelve RTK and storage parameters plus manual curve fitting to apply site specific knowledge to the genetic algorithm parameter estimation. Manual curve fitting is valuable in timing differences between monitored and calibrated wet weather flow components and employing previous experience in estimating RTK parameters.

“Innovyze continues to listen to our customers, invest very heavily in R&D, and deliver the advanced tools they need to effectively support their wastewater and urban drainage modeling and management challenges,” said Paul F. Boulos, Ph.D., BCEEM, Hon.D.WRE, Dist.D.NE, Dist.M.ASCE, NAE, President, COO and Chief Technical Officer of Innovyze.

“We are very excited that our vast worldwide customer base will now be able to use the powerful new features in *RDII*

Analyst to enhance

their modeling experiences, wrap better projects faster, and strengthen our communities’ sewer systems.”

Pricing and Availability

Upgrade to *RDII*

Analyst is now

available worldwide by subscription to the Executive program. Subscription members can immediately download the new version free of charge directly from www.innovyze.com.

The Innovyze Subscription Program is a friendly customer support and software maintenance program that ensures the longevity and usefulness of Innovyze products. It gives subscribers instant access to new functionality as it is developed, along with automatic software updates and upgrades.

For the latest information on the Innovyze Subscription Program, visit www.innovyze.com or contact your local Innovyze Channel Partner.

About Innovyze

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- See more at: http://www.innovyze.com/news/1667/#sthash.cYqDQqji.dpuf

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Innovyze Further Expands RDII Analyst Functionality, Setting New Standard for Sanitary and Combined Sewer System Model Calibration

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The new version delivers expanded functionality, incorporating many advanced Genetic Algorithm (GA) optimization features. It increases its unmatched productivity by openly inviting the users to further adjust the dry weather flow (DWF) and RTK parameters (with initial and maximum monthly storages for continuous simulation) to achieve a better fit and ultimately a better model based on their experiences. The release confirms Innovyze's commitment to giving the world the most complete toolset for modeling current sanitary and combined sewer collection systems.

Excessive wet weather flow from rainfall-derived manhole and pipe defect inflow and infiltration is a major source of sanitary and combined sewer overflows. Controlling these overflows is vital in reducing risks to public health and protecting the environment from water pollution. Computer modeling plays an important role in determining sound and economical remedial solutions that reduce RDII; improve system integrity, reliability and performance; and avoid overflows.

The processes for converting rainfall to RDII flow in sanitary sewer systems are very complicated. In addition to rainfall and antecedent moisture conditions, factors controlling RDII responses include depth to groundwater, depth to bedrock, land slope, number and size of sewer system defects, type of storm drainage system, soil characteristics, and type of sewer backfill. Given this degree of complexity, flow-monitoring data must be combined with mathematical modeling and analytics to provide accurate results. The wastewater flow monitoring data obtained by sewer collection systems consists of dry-weather flow components, ground water flow and twelve (12) RDII flow components. A crucial step in successfully modeling sewer collection systems is the ability to decompose flow-monitoring data into RDII flow, ground water flow and dry weather flow and its flow pattern.

Significantly superior to the EPA Sanitary Sewer Overflow Analysis and Planning (SSOAP) program and powered by advanced GA optimization and comprehensive data analytics and scenario management, RDII Analyst provides the ability to quickly and reliably perform these types of advanced flow decomposition data monitoring. It has been updated with tabular comparisons between the observed and calibrated RDII data for each event, including R value, peak flow, hydrograph volume and depth. This allows the user to better evaluate simulated and monitored data and judge how well it correlates on a per event basis. The user can also directly edit estimated DWF mean values to apply site specific knowledge to the RDII Analyst DWF extraction algorithm. These altered DWF values can then be used to estimate the wet weather flow component of the monitored flow, using a combination of the DWF extraction algorithm and site-specific knowledge. The new version also allows direct edits to the twelve RTK and storage parameters plus manual curve fitting to apply site specific knowledge to the genetic algorithm parameter estimation. Manual curve fitting is valuable in timing differences between monitored and calibrated wet weather flow components and employing previous experience in estimating RTK parameters.

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Pricing and availability

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 MWH Soft Enhances SSO Communities with New Tool for State-of-the-Art Rainfall Dependent Inflow and Infiltration Planning and Analysis

MWH

Soft Enhances SSO Communities with New Tool for State-of-the-Art Rainfall Dependent Inflow and Infiltration Planning and Analysis

Revolutionary RDII Analyst Extension Addresses Critical Wastewater Utilities' Need to Mitigate Pollution from SSOs

Broomfield, Colorado USA, April 2008 — MWH Soft, a leading global provider of environmental and water resources applications software, once again moved the wastewater industry to the head of the line for key new modeling capabilities with the release of RDII Analyst Extension for InfoSWMM and H2OMAP SWMM executive suites. The new extension offers invaluable risk management capabilities for planning and designing high-cost Sanitary Sewer Overflow (SSO) control.

RDII Analyst directly addresses industry challenges to develop sound capital improvement programs and the need for SSO mitigation plans that safeguard against hazards and limit liabilities by greatly accelerating accurate analysis of sanitary sewer systems capacity and helping to ensure reliable and effective SSO control plans. The introduction sets new benchmarks in sanitary sewer overflow analysis, planning and management.

Excessive Rainfall Dependent Inflow and Infiltration (RDII) can reduce sanitary sewer carrying capacity, causing sewer surcharge and overflows to basements, streets, or nearby streams. It can also cause serious operational problems at wastewater treatment plants. Together, the nation's 19,500+

sanitary sewer collection systems, serving an estimated 150 million people, report about 40,000 SSO events each year.

The ability to accurately predict RDII flows is critical to performing sound capacity analysis of sanitary sewer systems and determining effective and economical remedial measures. The industry standard and most accurate RDII prediction method is the USEPA RTK synthetic unit hydrograph. This method uses up to three triangular unit hydrographs to estimate fast, medium, and slow RDII responses. The R parameter is the fraction of rainfall volume entering the sewer system as RDII, T is the time to peak, and K

is the ratio of time of recession to T.

These parameters are normally computed through a tedious and inexact trial-and-error process in which they are adjusted to closely match wet-weather flow data. Since there are a vast number of possible combinations of RTK

values, evaluating all options this way is unfeasible, and even knowledgeable modelers often fail to obtain good results. As the size of the sewer system and number of flow datasets increase, the trial-and-error approach may not be effective or reliable, or even manageable — especially with the added factor of time and cost constraints. The result is inefficient performance at a greater cost.

The new RDII Analyst extension greatly improves the reliability of RDII flow prediction and eliminates the need for trial-and-error parameter estimations. The program performs rigorous QA/QC of rainfall and meter data and decomposes flow data into dry-weather flow (DWF) and wet-weather flow (RDII) components. The DWF component is further analyzed to construct a DWF pattern. This pattern is then assigned to the source nodes that contribute flow to the meter location, proportional to sewershed areas or based on any other user-defined criteria.

Using advanced Genetic Algorithm optimization, RDII Analyst then quickly and automatically determines the RTK parameters that best match the RDII time series generated by decomposing the measured flow data. The resulting inflow hydrograph (RDII + DWF) is then used by InfoSWMM or H2OMAP SWMM

to carry out detailed dynamic flow routing through the sewer system and evaluate system response to support development of an optimal capital improvement program.

Powerful, comprehensive and engineer-friendly, RDII Analyst reflects MWH Soft's time-honored practice of continually adding value to its world-class software and bringing critical new design and optimization capabilities to the wastewater industry. It allows engineering professionals to quickly and efficiently complete complex SSO projects and develop sound mitigation plans. The program's intuitive interface, easy-to-use functionality and rich graphing and reporting capabilities save modelers hours, if not days, of manual calculation time, making it simple to predict, analyze and optimize RDII flows for capacity analysis and SSO planning.

"The operational simplicity, power, speed and flexibility of RDII Analyst eliminate the obstacles that make RDII planning and analysis overly complicated and inefficient," commented Paul F. Boulos, Ph.D, President and COO of MWH Soft. "Civil and environmental engineers' SSO projects are very complex, but their tools shouldn't be. These professionals have long needed a versatile, engineer-friendly product that can quickly and accurately predict RDII flows and speed up project completion, and that's exactly what RDII Analyst gives them. The software's comprehensive capabilities will greatly assist wastewater modelers in making informed decisions that ensure optimal sewer system performance. With this introduction, we now offer the best in sanitary sewer collection system modeling and design, integrated with the best in engineering."

Pricing and Availability
RDII Analyst is now available worldwide by subscription to the InfoSWMM

or H2OMAP SWMM Executive Program. Subscription members can immediately download RDII Analyst free of charge directly fromwww.mwhsoft.com.

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Questions? Further Help Can be Found by Emailing Support@Innovyze.com **or by Using Our Social Media Websites or Searching the Internet for #INFOSWMM**