



Free Tools to Assess Ecosystem Services and Values of Trees



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What is i-Tree?



www.itreetools.org



A series of tools to quantify ecosystem services and values from trees



i-Tree is a
Cooperative
Initiative



i-Tree Quantifies Tree and Forest Resources



www.itreetools.org



Structure

- Number of Trees, species distribution, canopy cover, etc.

Functions / Ecosystem Services

- Energy
- Air pollution
- Carbon
- Biogenic VOC emissions

Management needs

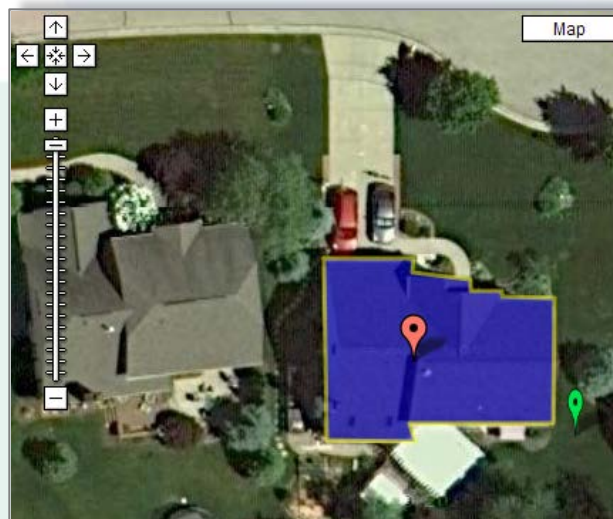
- Pest risk
- Tree health
- Exotic/invasive spp.

\$ Value



i-Tree is a
Cooperative
Initiative

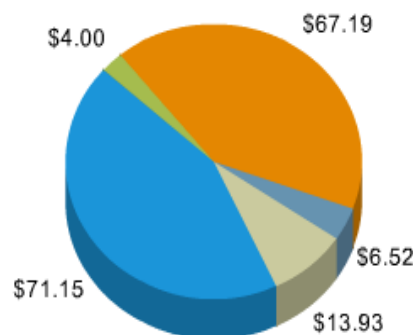




Northern pin oak
Quercus ellipsoidalis

Easily estimates ecosystem services of trees in your yard using Google Maps and i-Tree

■ Stormwater
 ■ Cooling
 ■ Heating
 ■ Air Quality
 ■ CO₂



Breakdown of your tree's benefits

This 21 inch Northern pin oak provides overall benefits of: \$163 every year.

While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees' specific geography, climate, and interactions with humans and infrastructure is highly variable and makes precise calculations that much more difficult. Given these complexities, the results presented here should be considered initial approximations—a general accounting of the benefits produced by urban street-side plantings.

Benefits of trees do not account for the costs associated with trees' long-term care and maintenance.

If this tree is cared for and grows to 26 inches, it will provide \$195 in annual benefits.



i-Tree Canopy

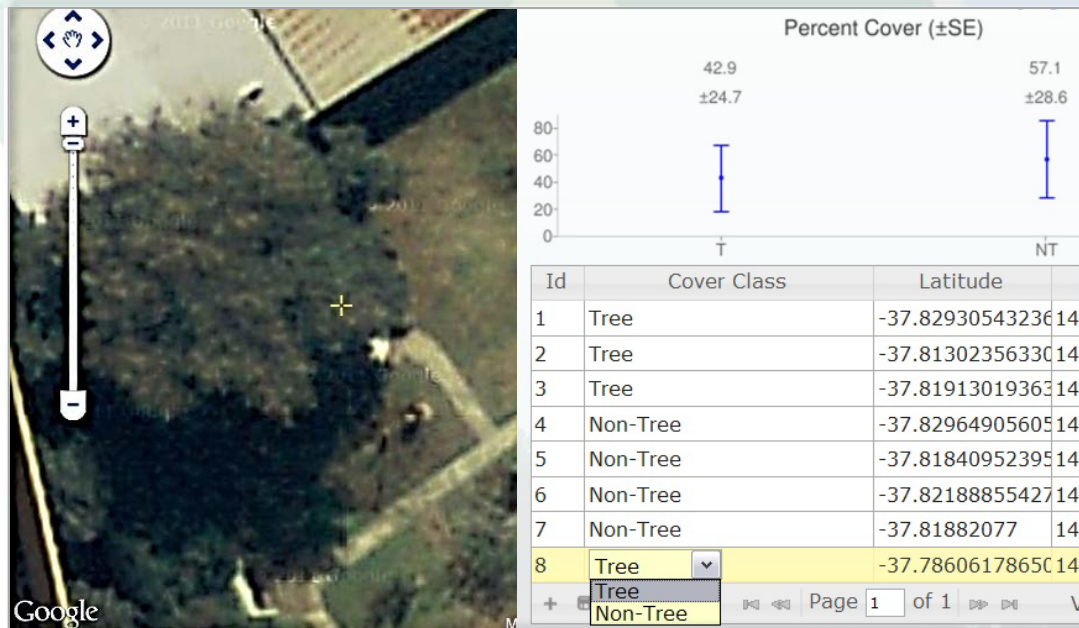
Get started in three easy steps!

One Browse to your project area boundary GIS file. The file must be in ESRI Shapefile format and in lat/long coordinates.

Two Configure the cover classes for your survey.

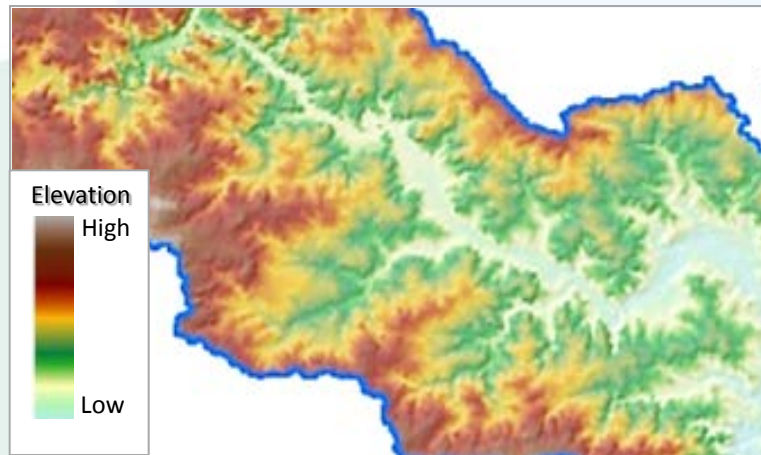
Three Begin i-Tree Canopy Survey

Been here before?
Already started an i-Tree Canopy survey? Load it here and resume your work.



Determines % tree cover

- Easy & Fast
- World-wide
- Web-based

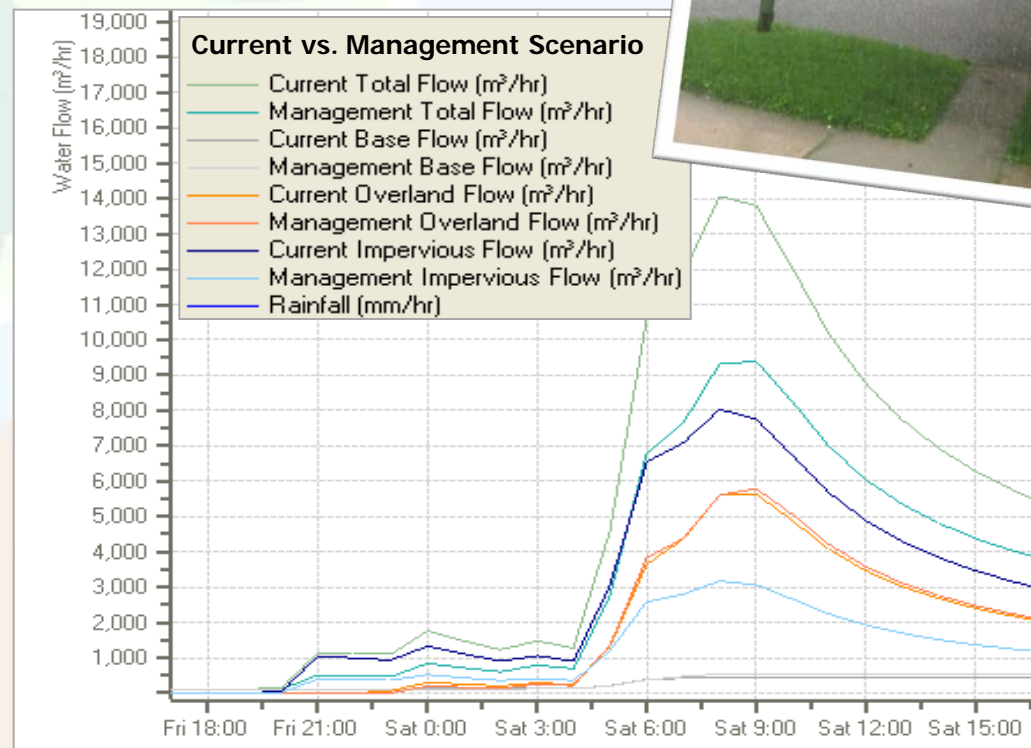


Quantifies effects of:

- Tree cover
- Impervious cover

on:

- Stream flow
- Water quality










Hydro Inputs

- 🌳 **Hourly discharge data (USGS)**
- 🌳 **Digital elevation map (USGS)**
- 🌳 **Hourly weather data**
 - 🌳 Evaporation data calculated from weather data
- 🌳 **Structural information on watershed**
 - 🌳 Tree cover
 - 🌳 Impervious cover
 - 🌳 Shrub and grass cover
 - 🌳 LAI

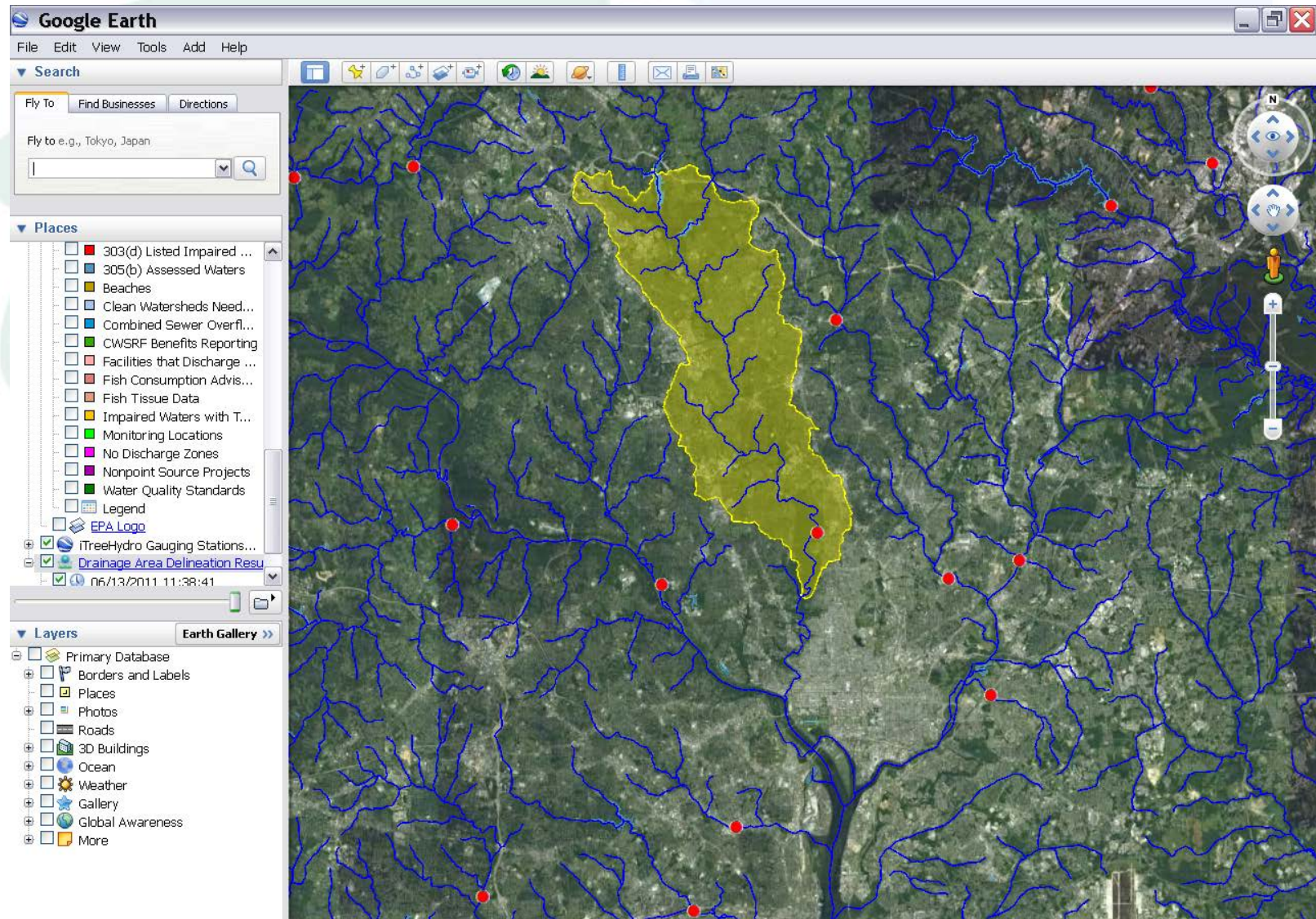
Hydro Outputs

 **For each time step (1 hour for these simulations):**

-  Canopy interception
-  Depression storage
-  Infiltration
-  Evapotranspiration
-  Surface and subsurface (base flow) runoff
-  Channel discharge (total runoff)
-  Water quality (EMC)

Step 1: Determine watershed

EPA Waters and gauging station data



Step 2: DEM



Urban Forest Map M... x (0 unread) Yahoo! ... x USGS ** USGS 0421... x Seamless Data War... x

seamless.usgs.gov/website/seamless/viewer.htm

Yahoo! Mail SFUFMP mail MW Dict Dict.com LEO xe XE.com Wikipedia Google Maps

The National Map Seamless Server

[\(Return to start page\)](#) [Tutorial](#)

Zoom

Query

Tools

Downloads

Documents

Layers

- ned_77764315
 - Value
 - High : 422.531
 - Low : 167.455

Spatial Analyst Tools

- Conditional
- Density
- Distance
- Extraction
- Generalization
- Groundwater
- Hydrology
 - Basin
 - Fill
 - Flow Accumulation
 - Flow Direction
 - Flow Length
 - Sink
 - Snap Pour Point
 - Stream Link
 - Stream Order
 - Stream to Feature
 - Watershed

Display Source Selection Map Book Favorites Index Search Results

-81.616 41.756 Decimal Degrees

The screenshot shows the National Map Seamless Server web interface. On the left is a sidebar with navigation tools like Zoom, Query, Tools, Downloads, and Documents. The main area displays a grayscale Digital Elevation Model (DEM) map with blue stream lines. A green rectangular box is drawn on the map to indicate a selection area. On the right, an ArcMap window is open, showing the 'Layers' panel with 'ned_77764315' selected, and the 'Spatial Analyst Tools' panel with 'Hydrology' tools expanded. The status bar at the bottom of the ArcMap window shows the coordinates '-81.616 41.756 Decimal Degrees'.

Click and drag to select area to download

Step 3: Cover Attributes



i-Tree Canopy - Windows Internet Explorer provided by USDA Forest Service

http://dev.itreetools.org/canopy/index.php

File Edit View Favorites Tools Help

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i-Tree Canopy

i-Tree Tools for Assessing and Managing Community Forests

Get the Tools.

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i-Tree Canopy

Get started in three easy steps!

One Browse to your project area boundary GIS file. The file must be in ESRI Shapefile format and in lat/long coordinates.

Load ESRI Shapefile ? Or Load Sample Project >

Two Configure the cover classes for your survey.

Configure Survey > ?

Three Begin i-Tree Canopy Survey > ?

Been here before?

Already started an i-Tree Canopy survey?
Load it here and resume your work.

Load Previous i-Tree Canopy Survey ?

More Information!

Technical Notes

With i-Tree Canopy, you can load a polygon boundary in ESRI Shapefile format on the map above and conduct a cover assessment for a project area.

- Collect data on your own cover classes of interest.
- 500-1000 survey points are suggested; the more points you complete, the better your assessment.

start David No... i-Tree V... 2 Micr... 2 Inter... Search Desktop 100% 12:04 PM

You choose the cover classes



i-Tree Canopy: Configure Survey - Windows Internet Explorer provided by USDA Forest Service

http://dev.itreetools.org/canopy/config.php

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i-Tree Canopy: Configure Survey

i-Tree Tools for Assessing and Managing Community Forests **Get the Tools.**

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i-Tree Canopy Configure Survey

? Help

Cover Classes

	Cover Class	Abbreviation	Description	Show Estimation
1	Tree	T	Tree, non-shrub	<input checked="" type="checkbox"/>
2	Non-Tree	NT	All other surfaces	<input checked="" type="checkbox"/>

+ ✎ 🗑️ ↺ Page 1 of 1 View 1 - 2 of 2

Add Record ✕

Cover Class
Abbreviation
Description
Show Estimation ☒

Submit Cancel

Done

start David No... i-Tree V... 2 Micr... 2 Inter... Search Desktop 100% 12:06 PM

Classify random points



i-Tree Canopy: Survey - Windows Internet Explorer provided by USDA Forest Service

http://dev.itreetools.org/canopy/survey.php

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i-Tree Canopy: Survey

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Technical Notes Report Export Start Over Exit ?

Map Satellite

42.9
±24.7

57.1
±28.6

Percent Cover (±SE)

Id	Cover Class	Latitude	Longitude
1	Tree	-37.82930543236	144.91265730117
2	Tree	-37.81302356330	144.95401488007
3	Tree	-37.81913019363	144.97617933379
4	Non-Tree	-37.82964905605	144.98052520547
5	Non-Tree	-37.81840952395	144.97104739912
6	Non-Tree	-37.82188855427	144.94620800253
7	Non-Tree	-37.81882077	144.92805906653
8	Tree	-37.78606178650	144.94090887519

Page 1 of 1 View 1 - 8 of 8

Remember, the more points you survey, the lower your Standard Error, and the more precise your sampling will be. More points surveyed provide for a better estimation of

Save Your Data

start David No... i-Tree V... 2 Micr... 2 Inter... Search Desktop 100% 12:09 PM

Step 4: Start Hydro



i-Tree Hydro

File Input Reports View Help

i-Tree Hydro Raw Data Input

Nearest Place to Center of Watershed

State County City

Initial Data *

Watershed Land Area (m²)

Percent Tree Cover

Tree Leaf Area Index

Percent Evergreen Tree Cover

Start Date / Time

End Date / Time

Process Stream Gauge Data

Select by Map OR Select File

Process Weather Data

Select by Map OR Select File

* If Initial Raw Data Input values are changed, you must reprocess the original Stream Gauge and Weather Data and then recalibrate Hydrological parameters using the Configuration Input form.

OK Cancel

i-TreeTM

Hydro

Extract Steam Data



i-Tree Hydro Streamgauge Selector

Map Type: Normal

Go To Location:

Go

Zoom Level: 9

ID: 01648000

Details

EEK AT SHERRILL DRIVE WASHINGTON, DC

ROCK CREEK AT SHERRILL DRIVE WASHINGTON, DC
ROGNEL HGTS STORM SEWER OUTFALL AT I
S BRANCH CHOPAWAMSIK CREEK NR GARRI
S F CATOCTIN CREEK AT RT 698 NEAR WATE
S F QUANTICO CREEK NEAR INDEPENDENT H
S F SHENANDOAH RIVER AT FRONT ROYAL, V
S F SHENANDOAH RIVER NEAR LURAY, VA
SALLIE HARRIS CREEK NEAR CARMICHAEL, M

Select: Left Click Marker
Zoom: Mouse Wheel
Pan: Right Click & Drag

OK Cancel

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ROCK CREEK AT SHERRILL DRIVE WASHINGTON, DC

Extract Weather Data



i-Tree Hydro Weather Station Selector

A map of the Northeastern United States, including parts of Pennsylvania, Maryland, Delaware, New Jersey, New York, and Virginia. The map shows major highways (Interstates 30, 76, 79, 80, 81, 85, 95, 99, 64, 60, 11, 22, 301, 76, 79, 80, 81, 85, 95, 99, 64, 60, 11, 22, 301) and various cities. Numerous green pin markers are placed across the map, indicating the locations of weather stations. The pins are concentrated in the Philadelphia area, the Washington DC area, and the New York City area.

Map Type: Normal

Go To Location:

Go

Zoom Level: 7

ID

Details

Select: Left Click Marker
Zoom: Mouse Wheel
Pan: Right Click & Drag

OK Cancel

Load files and enter cover data



Hydro Configuration

Initial Setup | Current Land Cover | Hydrological Parameters | Advanced Settings

Routing Method * Time Constant Routing

File Input

DEM c:\Program Files\i-Tree\Hydro\Sample Data\dem.dat Browse

Weather c:\Program Files\i-Tree\Hydro\Sample Data\WeatherData.dat Browse

Channel Routing Browse Create

Stream Gauge Data c:\Program Files\i-Tree\Hydro\Sample Data\qobs.dat Browse

Nearest Place to Center of Watershed

State Colorado County Blanco City Denver

Initial Data **

Watershed Area (m²) 28757700

Percent Evergreen Tree Cover (0-100) 10.6

Percent Evergreen Shrub Cover (0-100) 15.9

Start Date / Time 01/01/2007 00:00:00

End Date / Time 12/31/2007 00:00:00

* After changing Routing Method, please recalibrate Hydrological Parameters

** Must be set with Raw Data Input form

☒ Show Advanced Settings Load From File Save to File OK Cancel

Hydro Configuration

Initial Setup | **Current Land Cover** | Hydrological Parameters | Advanced Settings

Surface Cover Types

Tree Cover (%) *	13.4	Tree LAI	3.89
Shrub Cover (%)	48.2	Shrub LAI	2.2
Herbaceous Cover (%)	0	Herbaceous LAI	0
Water Cover (%)	0		
Impervious Cover (%)	31.0	Connected Impervious to Stream (%)	40.0
Soil Cover (%)	7.4		
Total Cover (%) (Should = 100)		100.0 %	

Cover Types beneath Tree Cover

Shrub Cover (%)	0		
Herbaceous Cover (%)	0		
Soil Cover (%)	95.5		
Impervious Cover (%)	4.5		
Total Cover (%) (Should = 100)		100.0 %	

* Must be set with Raw Data Input form

☒ Show Advanced Settings Load From File Save to File OK Cancel

Step 5: Calibrate Model

Hydro Configuration

Initial Setup | Current Land Cover | **Hydrological Parameters** | Advanced Settings

Auto-Calibrate Parameters | Check Calibration

Current Parameter Set: Initial Values (v) Save Save as New Parameter Set Delete Parameter Set

Simulation Parameter	Initial Value
Number of Index Increments	1
Scale Parameter of Power Function	2
Scale Parameter of Soil Transmissivity: (m)	0.03
Transmissivity at Saturation : To(m ² /h)	0.2
Unsaturated Zone Time Delay : Td(h)	10
Maximum Root Zone Storage Deficit (m)	0.022
Percent of Watershed Generating Infiltration Excess Overland Flow	30.0

Specific Hydraulic Load

Septic Hydraulic Load (m/day) 0

Time Constant of Watershed (b) 1

Channel Routing Velocity

Main Channel Routing Velocity (m/h) 950

Internal Channel Routing Velocity (m/h) 950

Infiltration Parameter

Wetting Front Suction (m) 0.12

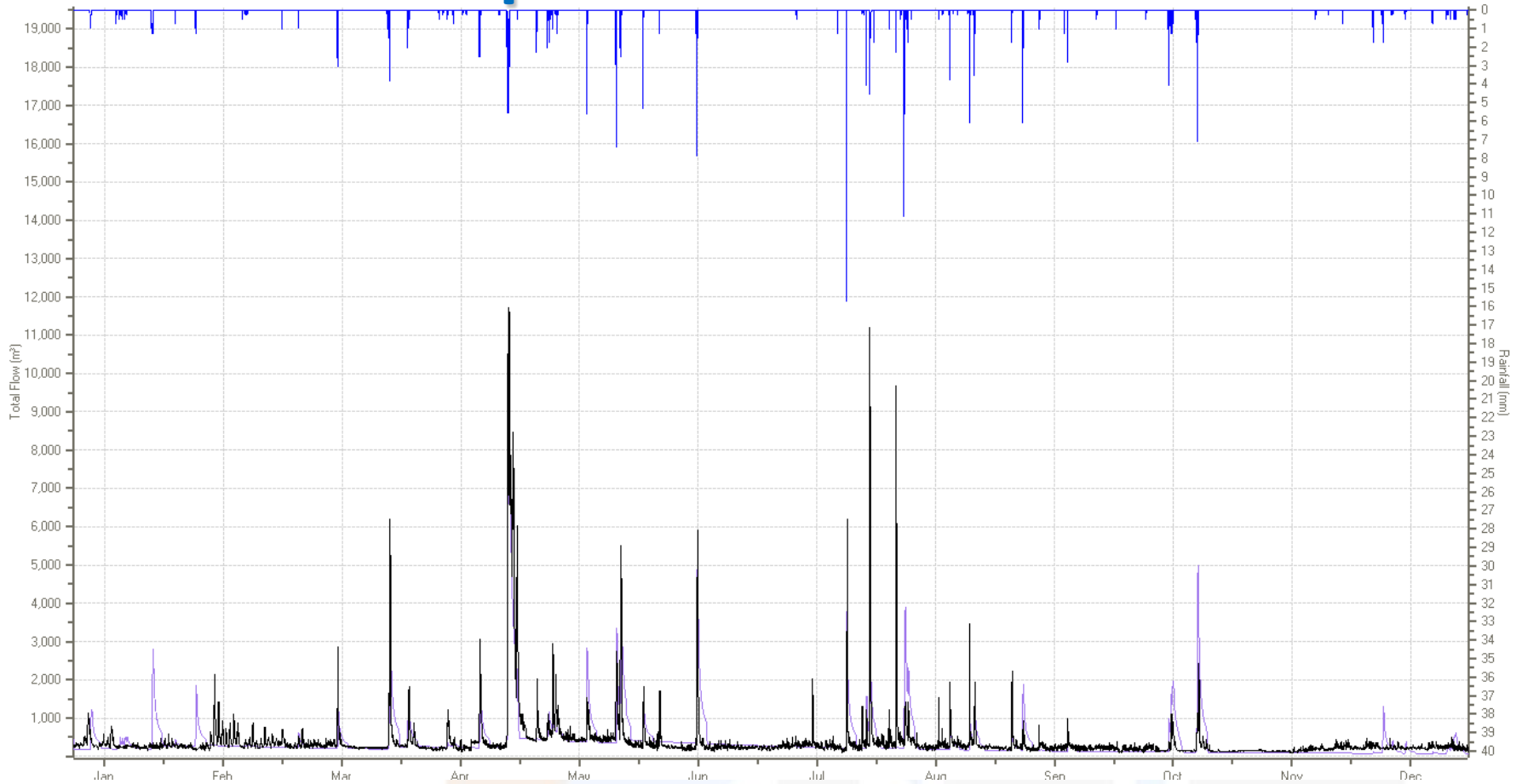
Wetted Moisture Content (m) 0.48

Surface Hydraulic Conductivity (m/h) 0.002

Impervious Depression Storage (mm) 1.5

☒ Show Advanced Settings Load From File Save to File OK Cancel

Calibration Graph



Calibration coefficients and percent connected impervious area for select watersheds

Watershed	Peak Flow	Calibration Coefficients			% Connected Impervious
		Base Flow	Balanced Flow		
Accotink	0.32	0.49	0.58		65
Baisman Run	0.55	0.63	0.70		20
Gwynns Falls	0.51	0.45	0.61		65
Mill Creek	0.62	0.10	0.43		65
Pond Branch	0.55	0.26	0.55		65
Rock Creek	0.56	0.53	0.67		65

Step 6: Model Scenarios



i-Tree Hydro - DryCreekSample

File Input Reports View Help

Display:

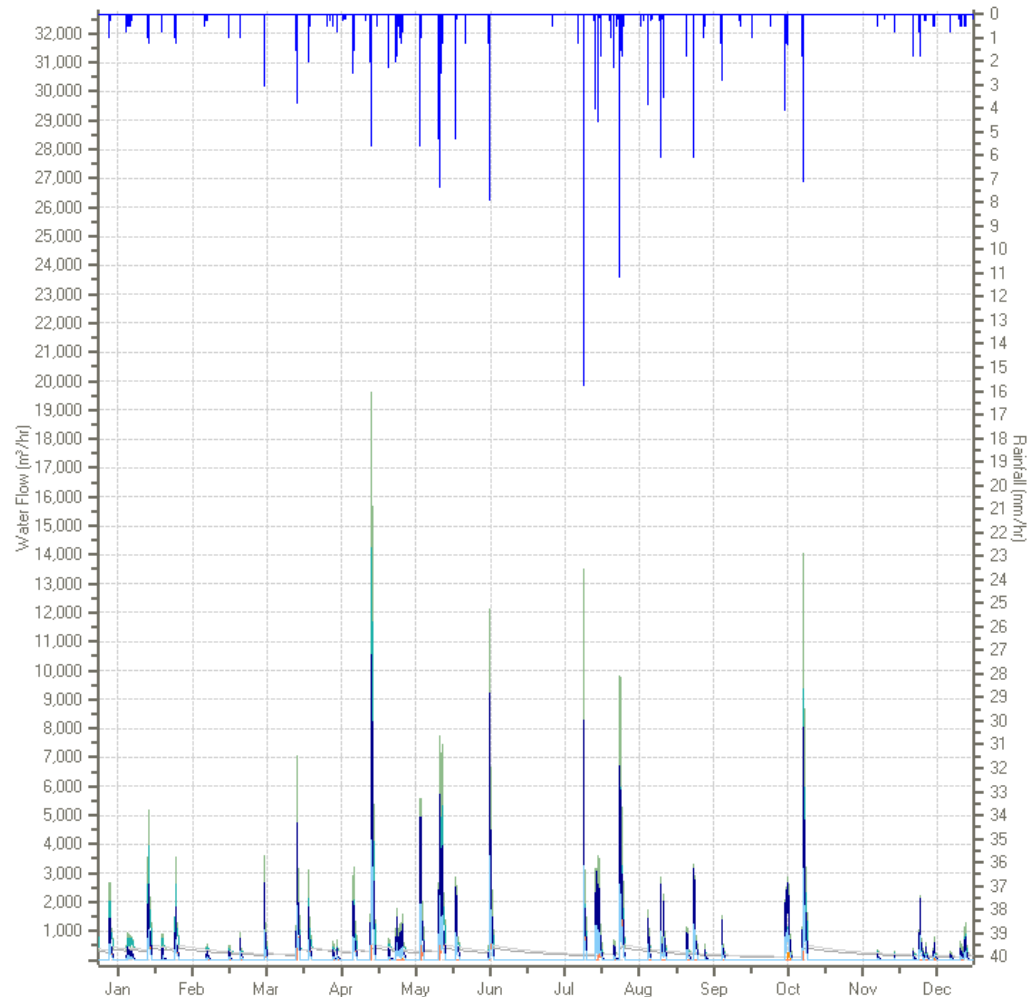
- ☒ Total Flow
- ☒ Base Flow
- ☒ Overland Flow
- ☒ Impervious Flow

Graph Table



Export ☒ Display Legend

Current vs. Management Scenario

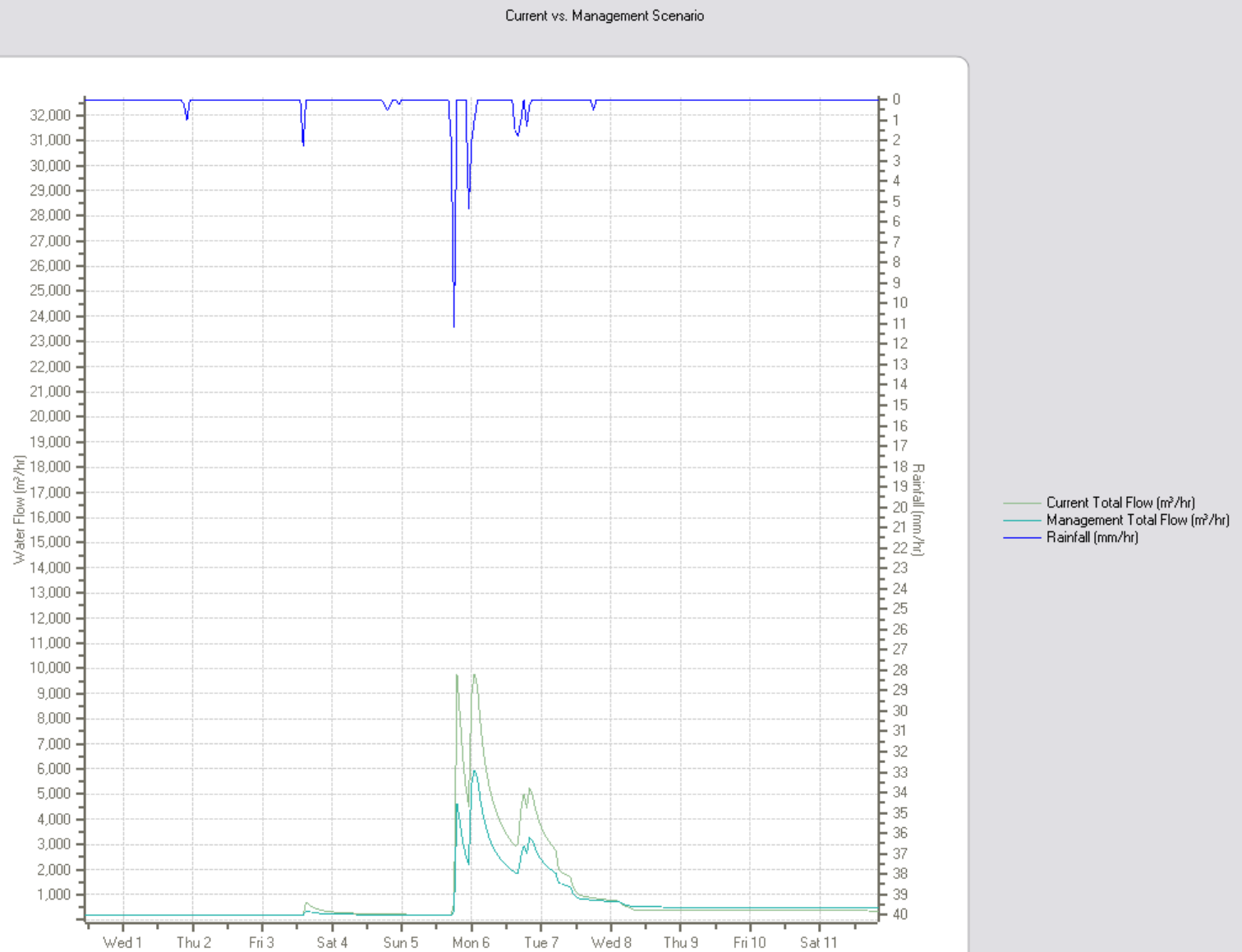


- Current Total Flow (m³/hr)
- Management Total Flow (m³/hr)
- Current Base Flow (m³/hr)
- Management Base Flow (m³/hr)
- Current Overland Flow (m³/hr)
- Management Overland Flow (m³/hr)
- Current Impervious Flow (m³/hr)
- Management Impervious Flow (m³/hr)
- Rainfall (mm/hr)

Display:

- | | | |
|--|--|--|
| <input checked="" type="checkbox"/> Total Flow | | |
| <input type="checkbox"/> Base Flow | | |
| <input type="checkbox"/> Overland Flow | | |
| <input type="checkbox"/> Impervious Flow | | |

Graph Table

Export ☒ Display Legend

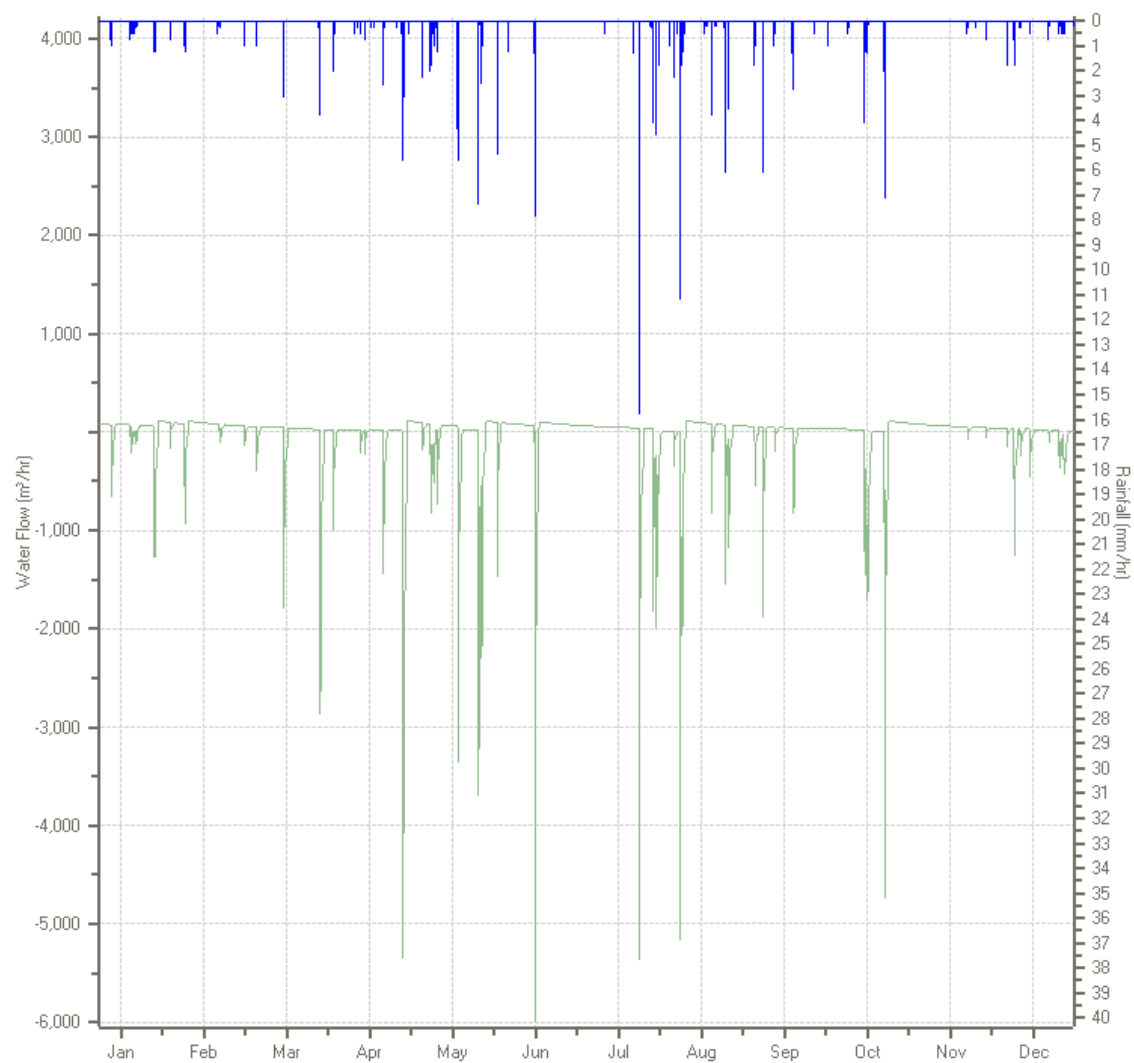
Display:

<input checked="" type="checkbox"/> Total Flow	
<input type="checkbox"/> Base Flow	
<input type="checkbox"/> Overland Flow	
<input type="checkbox"/> Impervious Flow	

Graph Table

Export ☒ Display Legend

Management - Current Scenario



Management Total Flow (m^3/hr)
Rainfall (mm/hr)

Table Outputs



i-Tree Hydro - DryCreekSample

File Input Reports View Help

Display:

- ☒ Total Flow
- ☐ Base Flow
- ☐ Overland Flow
- ☐ Impervious Flow

Graph Table

		Export	Total:			
Date/Time	Rainfall (mm/hr)	Discharge (m³/hr)	Total Runoff (m³/hr)	Future Total Runoff (m³/hr)	ΔTotal Runoff (m³/hr)	
01/01/2007 00:00:00	0	244.65757063500	726.41950200	808.8304428900	82.4109408900	
01/01/2007 01:00:00	0	244.65757063500	294.7002822900	377.01344700	82.3131647100	
01/01/2007 02:00:00	0	295.6291560000	294.3494383500	376.5619511100	82.2125127600	
01/01/2007 03:00:00	0	275.23965912300	293.9957186400	376.1104552200	82.1147365800	
01/01/2007 04:00:00	0	275.23965912300	293.644874700	375.661835100	82.016960400	
01/01/2007 05:00:00	0	295.6291560000	293.2940307600	375.2132149800	81.9191842200	
01/01/2007 06:00:00	0	244.65757063500	292.9460625900	374.7645948600	81.8185322700	
01/01/2007 07:00:00	0	275.23965912300	292.5952186500	374.3188505100	81.7236318600	
01/01/2007 08:00:00	0	275.23965912300	292.2472504800	373.8731061600	81.6258556800	
01/01/2007 09:00:00	0	275.23965912300	291.8992823100	373.4273618100	81.5280795000	
01/01/2007 10:00:00	0	214.07548214700	291.5513141400	372.9816174600	81.4303033200	
01/01/2007 11:00:00	0	316.0154895300	291.2033459700	372.5387488800	81.3354029100	
01/01/2007 12:00:00	0	275.23965912300	290.8582535700	372.095880300	81.2376267300	
01/01/2007 13:00:00	0	346.5993034800	290.5131611700	371.6530117200	81.1398505500	
01/01/2007 14:00:00	0	295.6291560000	290.1680687700	371.2130189100	81.0449501400	
01/01/2007 15:00:00	0	295.6291560000	289.8229763700	370.773026100	80.9500497300	
01/01/2007 16:00:00	0	275.23965912300	289.4807597400	370.3330332900	80.8522735500	
01/01/2007 17:00:00	0	316.0154895300	289.1356673400	369.8930404800	80.7573731400	
01/01/2007 18:00:00	0	316.0154895300	288.7934507100	369.4559234400	80.6624727300	
01/01/2007 19:00:00	0	316.0154895300	288.4512340800	369.018806400	80.5675723200	
01/01/2007 20:00:00	0	316.0154895300	288.1118932200	368.5816893600	80.4697961400	
01/01/2007 21:00:00	0	295.6291560000	287.7696765900	368.1445723200	80.3748957300	
01/01/2007 22:00:00	0	275.23965912300	287.42976057600	367.7103310500	80.28057047400	
01/01/2007 23:00:00	0	275.23965912300	287.09013213900	367.2760897800	80.18595764100	
01/02/2007 00:00:00	0	275.23965912300	286.75107885600	366.8418485100	80.09076965400	
01/02/2007 01:00:00	0	275.23965912300	286.41288830400	366.4104830100	79.99759470600	
01/02/2007 02:00:00	0	295.6291560000	286.07527290600	365.9762417400	79.90096883400	
01/02/2007 03:00:00	0	316.0154895300	285.73794508500	365.5448762400	79.80693115500	
01/02/2007 04:00:00	0	275.23965912300	285.40147999500	365.1163865100	79.71490651500	
01/02/2007 05:00:00	0	295.6291560000	285.06559005900	364.6850210100	79.61943095100	
01/02/2007 06:00:00	0	244.65757063500	284.73027527700	364.2565312800	79.52625600300	
01/02/2007 07:00:00	0	244.65757063500	284.39553564900	363.8280415500	79.43250590100	
01/02/2007 08:00:00	0	244.65757063500	284.06137117500	363.4024275900	79.34105641500	
01/02/2007 09:00:00	0	214.07548214700	283.72778185500	362.9739378600	79.24615600500	
01/02/2007 10:00:00	0	244.65757063500	283.39476768900	362.548323900	79.15355621100	

Water Quality (EMC)



i-Tree Hydro - DryCreekSample

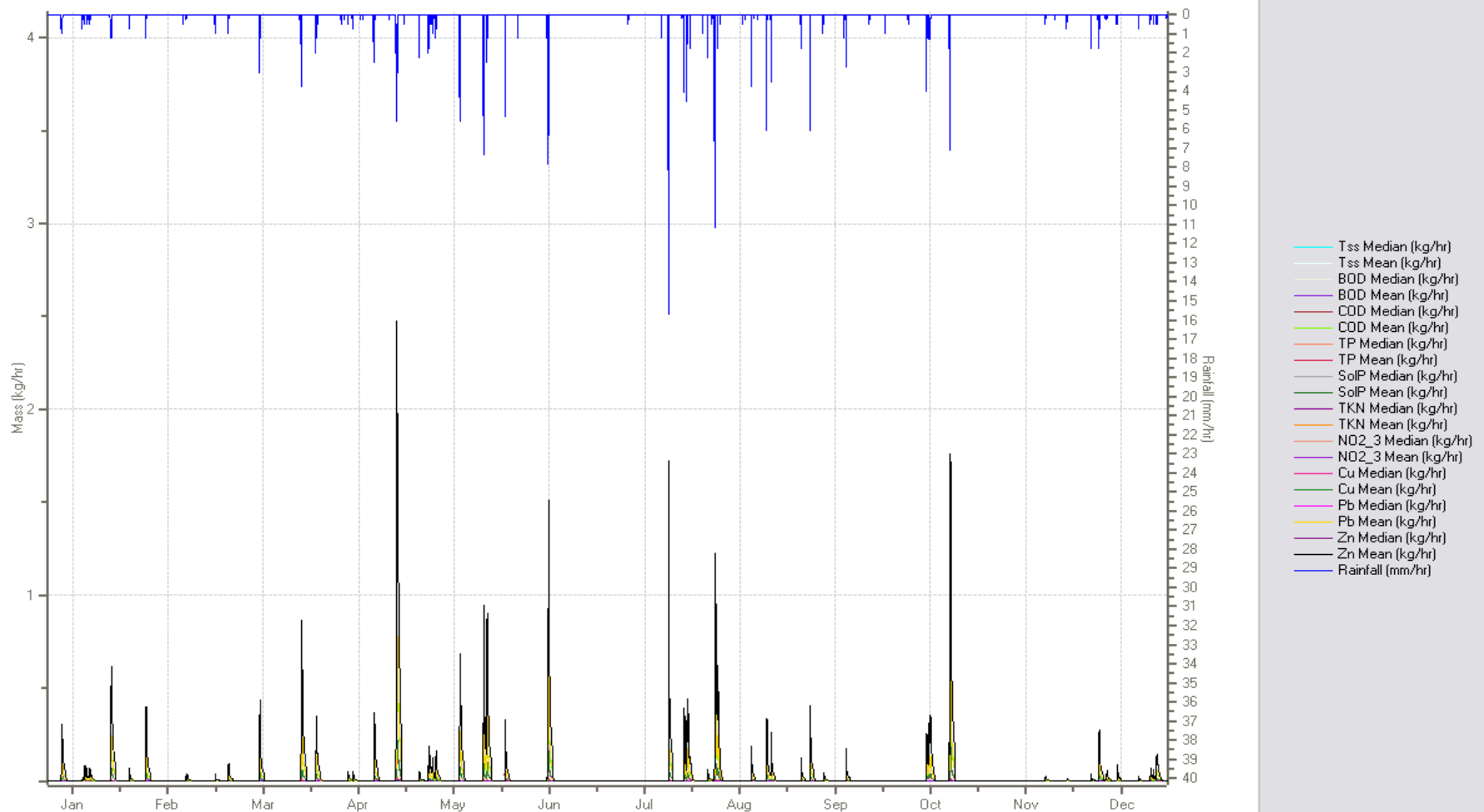


File Input Reports View Help

Graph Table

Export ☒ Display Legend

Current Scenario - Event Mean Concentration



EMC – contrasting scenarios



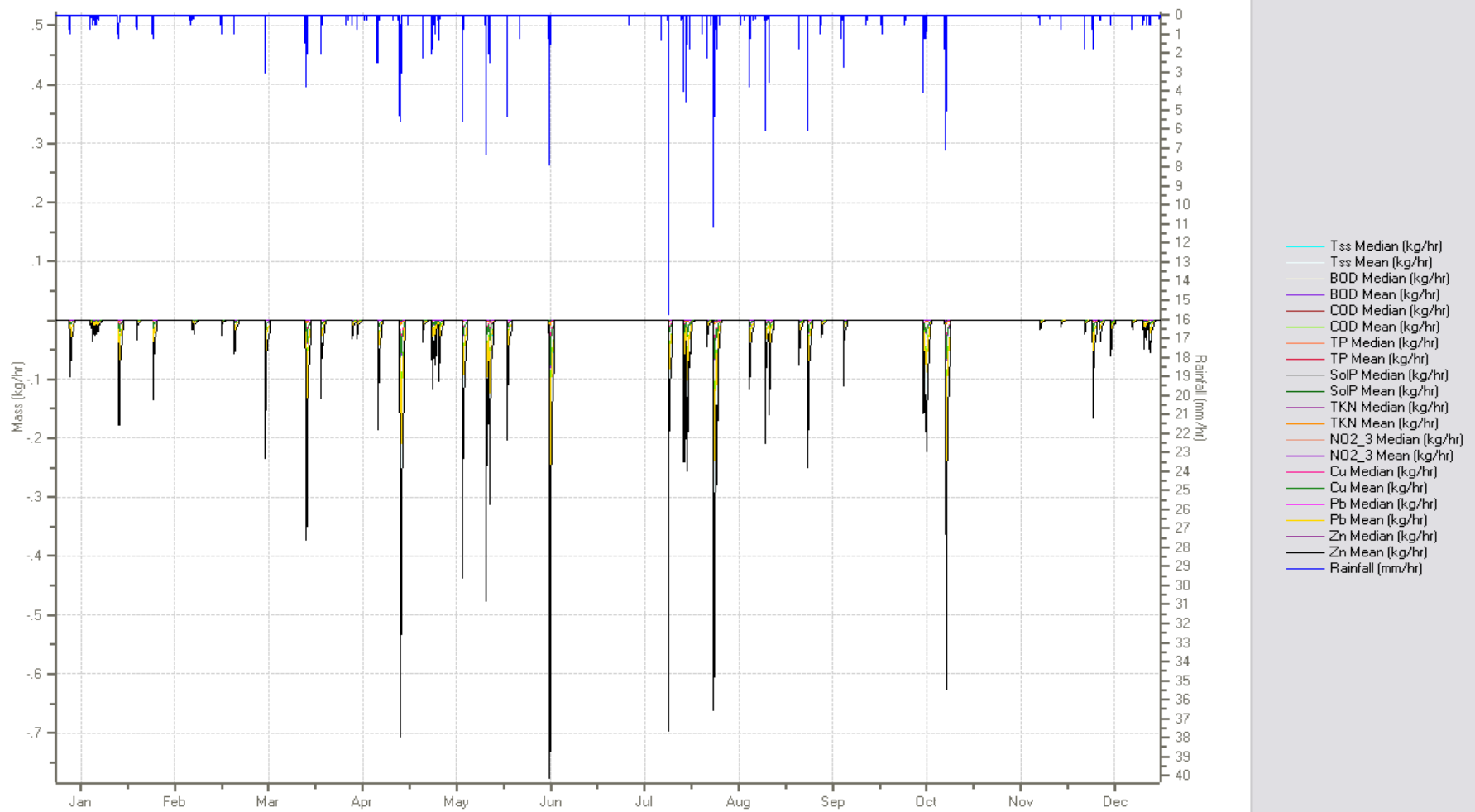
i-Tree Hydro - DryCreekSample

File Input Reports View Help

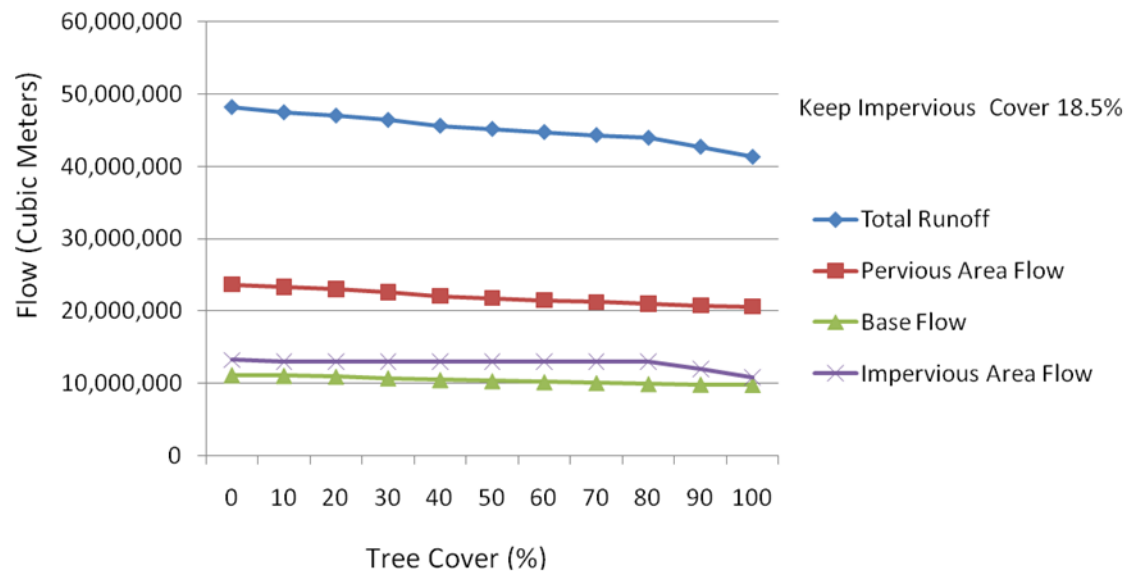
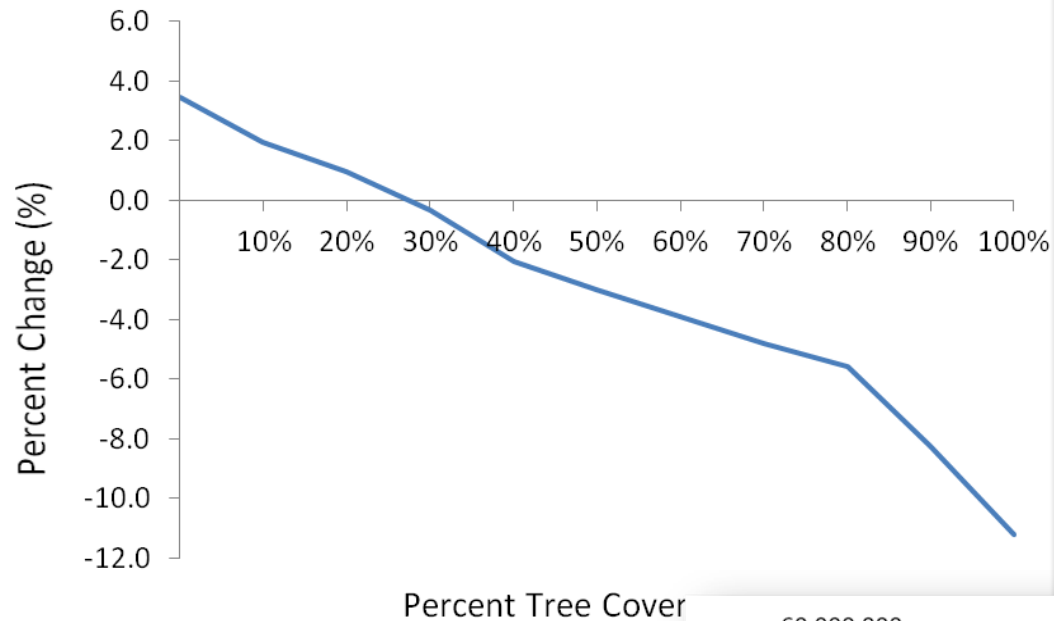
Graph Table

Export Display Legend

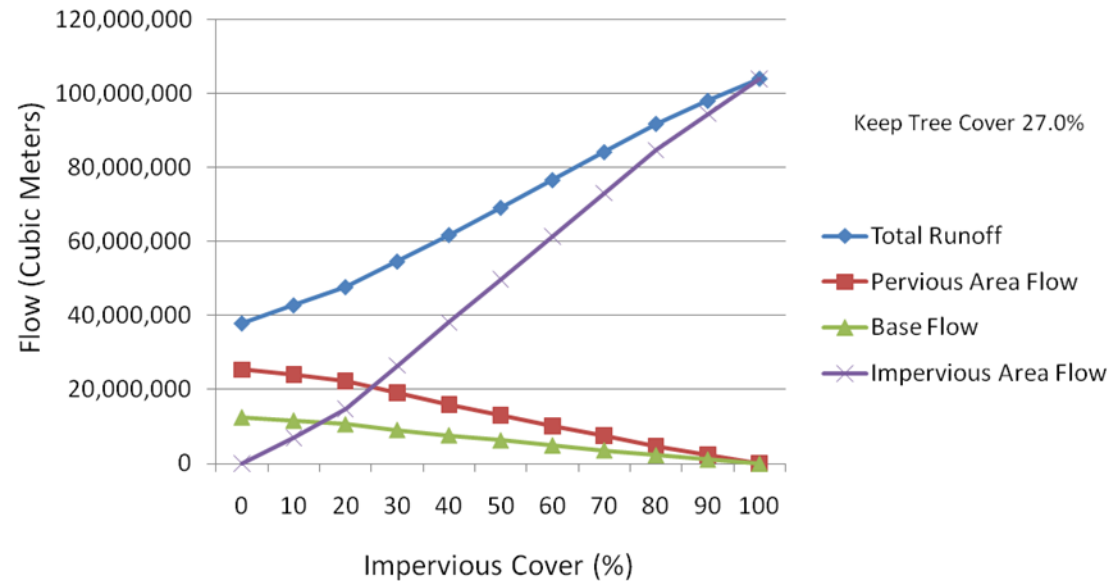
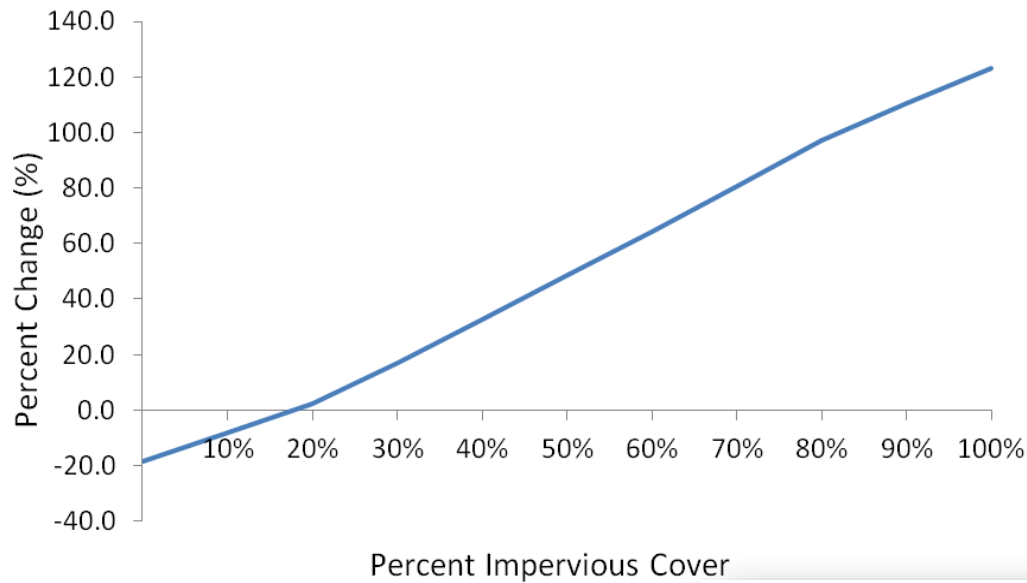
Event Mean Concentration: Management Scenario - Current Scenario



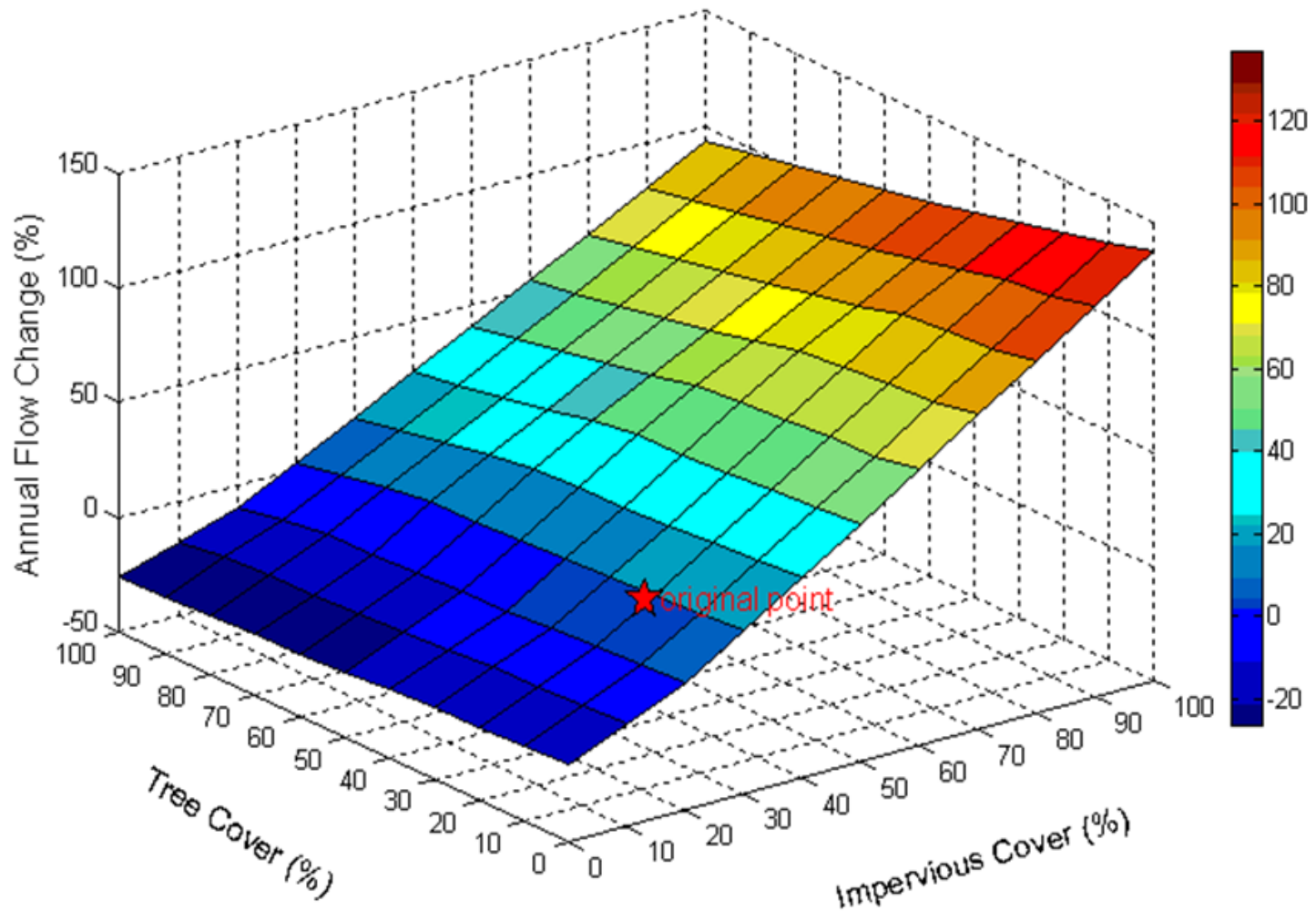
USFS Graphs (Rock Creek)



USFS Graphs (Rock Creek)



USFS Graphs (Rock Creek)



Next versions

- 🌳 **Snow melt routine (completed)**
- 🌳 **More fully distributed cells**
- 🌳 **NEXRAD precipitation data**
- 🌳 **Linking to i-Tree Eco and Design (non-watershed based)**

Summary

- ✦ **i-Tree is free and available to use**

- ✦ www.itreetools.org

- ✦ **Free tech support, manuals, forum**

- ✦ **Version 5 will be out in Spring 2012**

- ✦ Improvements to Hydro model

- ✦ **Looking for input on types of outputs and analyses desired for Hydro**

- ✦ Released in 2011



Questions?

dnowak@fs.fed.us

nrs.fs.fed.us/units/urban