

SARA Water Quality Modeling Tools



Agenda

- Background
- HSPF Model Development
- WQ Modeling Results & Tools
- Method for prioritizing where WQ improvements potentially need to be focused



San Antonio River Basin



Committed to Safe, Clean, Enjoyable Creeks and R³vers.

Impaired Waterbodies for Primary Contact Recreation



https://sara-tx.maps.arcgis.com/apps/MapSeries/index.html?appid=3a4ca132222e41589e6f41eebfe6d36d

Contact Recreation E-coli Standards

| E-Coli Standards | Concentration |
|--------------------------------|---------------|
| Primary Contact Recreation 1 | 126 #/dL |
| Primary Contact Recreation 2 | 206 #/dL |
| Secondary Contact Recreation 1 | 630 #/dL |
| Secondary Contact Recreation 2 | 1030 #/dL |
| Noncontact Recreation | 2060 #/dL |

*Source: Texas Surface Water Quality Standards



Water Quality Watershed Master Planning



To date: mostly <u>Qualitative</u>

- Best Management
- To the extent possible/practicable
- 303(d)/ Impairments listing based on monitoring data (CRP)
 - Quarterly monitoring temporal gap
 - Limited SWQM station locations spatial gap

• BMPs/LIDs planning:

- Little modeling; the "right kind" of models don't exist.
- Build first, then monitor to see effectiveness



Our Vision



Consultants: LAN and RESPEC (Aquaterra formerly)

Leon Creek Watershed



2005 Impervious Cover

2017 Impervious Cover

2040 Impervious Cover



USAR Watershed



2005 Impervious Cover

2017 Impervious Cover

Future Conditions Impervious Cover



WQ Modeling Tools

Approach and Tools to allow <u>quantitative</u> WQ planning

- SARA WQ modeling standards
- Timeseries Utility Tool
- Load Reduction Tool
- SARA Enhanced BMP Tool
 - BMP Database
- BMP Processor Tool

S A N A N T O N I O RIVER AUTHORITY

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River Authority Water Quality Modeling Standards

In 2013, the River Authority authored the Water Quality Modeling Standards document, which details guidelines on the development, calibration/validation, linkage, and applications of water quality models. The River Authority document is the first of its kind to help ensure the quality and consistency of all developed water quality models within the San Antonio River Basin.

River Authority Load Reduction Tool

The River Authority Load Reduction Tool enables users to determine the constituent load reductions necessary to reach WQ standards or screening levels that may be achievable through the application of BMPs/LIDs. The River Authority Load Reduction Tool automatically determines load reduction needed for all sub-basins within a watershed for each constituent to meet user-specified WQ constituent concentrations.

DOWNLOAD

River Authority Enhanced BMP Tool

The River Authority BMP Processor compiles individual BMP/LID unit-cost and effectiveness information to assess potential incentives for implementing BMPs/LIDs. The River Authority Enhanced BMP Tool determines the optimal combinations that would minimize the BMP/LID costs while achieving the needed load reduction. The River Authority Enhanced BMP Tool includes a comprehensive BMP Tool Database, compiling available BMP/LID data and the application of engineering economic analyses to convert the collected data to annual costs for equal-footing comparison and optimization. The River Authority Enhanced BMP Tool uses the EPA SUSTAINOPT as its core engine. The optimal results from SUSTAINOPT are then fed back into the HSPF model to verify the preferred load reductions are met.

DOWNLOAD



Data

- DFIRM
 - Subbasin delineation
 - Stream shapefile
 - HEC-HMS
 - HEC-RAS
- Topography
 - DĔM
 - Contours
- Aerial images
- SSURGO soil data
- Landuse & IC%
- Met data (NOAA)

- Rainfall
 - NOAA
 - EAA (gage, NEXRAD)
 - SARA
 - USGS
- Diversion
- Wastewater data
- USGS flow data
- Water Quality
 - SWQM
 - USGS
- 2020 303(d)
- Screening levels

- SSO
- OSSF (estimates)
- Dams/reservoirs
 - From HMS
- Groundwater recharge & spring flow
- Major development centers
- QUAL-TX models
- Atmospheric deposition*
- No relevant data
 - Agricultural data
 - SELECT or EC loading estimates



Calibration









Peer-Review Comments

- Overall, the setup of the model appears to have been an extensive and impressive effort with a high level of detail, especially in the spatial definition for both land uses and stream reaches.
- In summary, the model demonstrates that a significant and comprehensive effort was invested in this model development work. The models contain reasonable parameter sets, have no serious flaws (to our knowledge), and should provide a sound basis for future use.



SARA WQ Modeling Standards Document













SARA Timeseries Utility Tool

- Enhanced efficiency in reading large timeseries records (e.g. HSPF binary output).
- Developed, tested, and released to public through EPA BASINS user community on 10/24/2013.
- Replaced WDMUtil
- Added GSSHA Converter in 2014

| 😤 SARA Timeseries | Utility | | |
|--------------------------------|--|-------------------------|---|
| Open File Select Timeseries | Manage Files N S No Timeseries are selec | o files are open ted | 5 |
| View | Save | Compute | <u>s a n _ a n t o n i o</u> River Authority |
| List | Save List As Text | Meteorologic | |
| Graph | Save to WDM | Math | |
| Tree | Import Text to WDM | | About Help |



SARA Tools Suggested by National Experts

From: Tom Jobes [mailto:TJobes@sjrwmd.com]
Sent: Monday, April 18, 2016 10:09 AM
To: Private list for BASINS users
Subject: RE:[basinsinfo] WdmUtil and Office 2016

Thanks for the reply, Laura. There is no special connection with Office products – it's simply that the Office 2016 installation apparently breaks some system call used by WdmUtil, probably by updating a system DLL in a way that makes it incompatible with the old programs. Uninstalling and reinstalling WdmUtil etc. does not help. Virtual XP might be worth looking at as a temporary fix, though I do recommend for you (and my colleagues) to make the move to SARA and BASINS 4 in the long run.

Tom Jobes

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SARA Load Reduction Tool



- Uses load reduction factors in HSPF BMP Module.
- Automates tedious process for large watershed models.
- Compared to manual processes.
- Developed, tested, and released to public through EPA BASINS user community on 5/09/2014.

SARA Load Reduction Tool

| ☆ | SARA | Load Red | duction | Tool Ve | ersion 1. | 0 (Janu | iary, 20 | 14) | | | | | | |
|---|-------|---|---------|---------|-----------|---------|----------|-------|----------|----------|-------|-------|-------|--------------------------------|
| I | UCI: | CI: G:\Admin\ATKINS\LeonCk4Yr2\LeonCk_HSPF11_89.uci | | | | | | | | | | | | ٨ |
| ! | Spec: | pec: G:\Admin\ATKINS\LeonCk4Yr2\LeonCk_HSPFall.Ittspec Browse | | | | | | | | | | | | TÀ |
| | Apply | BMP | Run Ma | odel | Spec Te | mplate | Re | port | 🗹 Auto R | ur 🗹 Sta | tus | Help | | SAN ANTONIO RIVER AUTHORITY |
| | Reach | BACT | TEMP | CBOD | ORGN | NH3N | NO3N | ORGP | ORTHOP | SED | PB | ZN | CHLA | |
| | 10 | 79.222 | 19.157 | 1.580 | 0.181 | 0.013 | 0.484 | 0.024 | 0.008 | 26.072 | 0.103 | 1.752 | 0.016 | |
| | 20 | 89.995 | 19.463 | 1.623 | 0.177 | 0.013 | 0.500 | 0.025 | 0.008 | 39.277 | 0.102 | 1.722 | 0.017 | |
| | 30 | 126.000 | 20.476 | 1.476 | 0.134 | 0.016 | 0.479 | 0.020 | 0.012 | 49.988 | 0.140 | 1.854 | 0.012 | |
| | 40 | 125.590 | 20.454 | 1.770 | 0.175 | 0.017 | 0.500 | 0.031 | 0.016 | 50.000 | 0.107 | 2.112 | 0.014 | |
| | 50 | 126.000 | 21.262 | 1.999 | 0.215 | 0.028 | 0.483 | 0.044 | 0.032 | 50.000 | 0.117 | 2.684 | 0.014 | |
| | 60 | 125.230 | 21.883 | 2.000 | 0.377 | 0.056 | 0.500 | 0.050 | 0.040 | 50.000 | 0.193 | 5.000 | 0.900 | |
| | 70 | 136,400 | 21.133 | 2.000 | 0.544 | 0.039 | 0.500 | 0.079 | 0.035 | 50.000 | 0.125 | 3.393 | 4.050 | |
| | 80 | 125.950 | 21.962 | 1.943 | 0.383 | 0.073 | 0.497 | 0.048 | 0.039 | 50.000 | 0.143 | 5.000 | 0.198 | |
| | 90 | 126.000 | 22.387 | 1.998 | 0.335 | 0.060 | 0.500 | 0.048 | 0.040 | 50.000 | 0.133 | 4.492 | 0.029 | |
| | 100 | 139,450 | 21.687 | 1.993 | 0.528 | 0.045 | 0.500 | 0.076 | 0.039 | 49.960 | 0.140 | 4.155 | 3.441 | |
| | 110 | 126.000 | 22.821 | 1.991 | 0.299 | 0.051 | 0.493 | 0.050 | 0.038 | 50.000 | 0.137 | 3.896 | 0.034 | |
| | 120 | 126.000 | 22.099 | 1.999 | 0.383 | 0.070 | 0.500 | 0.049 | 0.039 | 50.000 | 0.152 | 4.554 | 1.078 | |
| | 130 | 126.000 | 22.145 | 2.000 | 0.349 | 0.054 | 0.500 | 0.050 | 0.037 | 50.000 | 0.142 | 4.047 | 0.709 | |
| | 140 | 362.310 | 24.953 | 1.828 | 0.279 | 0.037 | 0.373 | 0.047 | 0.041 | 95.779 | 0.187 | 4.717 | 0.026 | • |



SARA Enhanced BMP Tool

- Identify LID/BMPs to achieve needed load reductions.
- Use LRT results or any calibrated HSPF models.
- Combines robust land surface representation from HSPF with EPA SUSTAIN's BMP capabilities.
- Avoids ArcGIS version issue inherent in SUSTAIN by using non-GIS component (SUSTAINOPT)

| Specification File | | | |
|--------------------------------|---------------------------------------|-------------|----------------|
| E:\LeonEx-SUB290-P0001-CEV\Leo | nCk_HSPF11_92_over_try156_hourly.bmps | spec x Open | \checkmark |
| Create New Edit | | | SAN ANTONIO |
| | | | RIVER AUTHORIT |
| Write SUSTAINOPT Inputs | Compile for BMP Processor | | Graph |
| | | | |



BMP Tool Workflow Diagram





SARA BMP Tool Database

| ×∃ | 5 d | - 🕰 - 👳 | | SustainB | MPParameters_021015 | TextO | nly - Excel | | | | ? 2 | | x t |
|------|------------|---|--------------------------------------|----------|---------------------|---------------|--|-------------------------------|---------------------------------------|--|------------------|------------|-----|
| FI | LE HOME | INSERT PAGE LAYOU | T FORMULAS | data f | REVIEW VIEW | | | | | | Juhn | -Yuan Su 👻 | |
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| F26 | - | $\therefore \times \checkmark f_x$ | 5 | | | | | | | | | | ~ |
| | А | В | | | С | | D | Е | F | G | | н | |
| 2 | CBMPSITE | BMPNAME | | BMPT | YPE | | DArea | NUMUNIT | DDAREA | PreLUType | Aqui | iferID | |
| 3 | 1 | DryPond_Ave | | DRYPO | DND | | -99 | -99 | 10 | | 1 | 0 | |
| 4 | 2 | ExtendedDetentio | n_Small | DRYPO | DND | | -99 | -99 | 10 | | 1 | 0 | |
| 5 | 3 | ExtendedDetentio | n_Ave | DRYPO | DND | | -99 | -99 | 42.5 | | 1 | 0 | |
| 6 | 4 | ExtendedDetentio | n_Large | DRYPO | DND | | -99 | -99 | 75 | | 1 | 0 | |
| 7 | 5 | StreetSweep_Arte | erial_4X | DRYPO | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 8 | 6 | StreetSweep_Arte | erial_4X_New | DRYPO | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 9 | 7 | StreetSweep_Arte | erial_8X | DRYPO | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 10 | 8 | StreetSweep_Arte | erial_8X_New | DRYPO | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 11 | 9 | StreetSweep_Res | sid_2X | DRYPO | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 12 | 10 | StreetSweep_Res | sid_2X_New | DRYPO | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 13 | [11 | StreetSweep_Res | sid_4X | DRYPO | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 14 | 12 | StreetSweep_Res | sid_4X_New | DRYPO | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 15 | 13 | StreetSweep_CBI | D_363 | DRYPO | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 16 | 14 | StreetSweep_CBI | D_363_New | DRYPO | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 17 | [15 | StreetSweep_CBI | D_182 | DRYPO | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 18 | 16 | StreetSweep_CBI | D_182_New | DRYP | DND | | -99 | -99 | 1 | | 1 | 0 | |
| 19 | 20 | RainBarrel_Ave | | RAINB | ARREL | | -99 | -99 | 0.01377 | | 1 | 0 | _ |
| 20 | 30 | BioRetentionBasin | n_Ave | BIORE | TENTION | | -99 | -99 | 2.5 | | 1 | 0 | |
| 21 | 31 | BioRetentionBasin | _Small | BIORE | TENTION | | -99 | -99 | 0.03061 | | 1 | 0 | |
| 22 | 32 | BioRetentionBasin | _Large | BIORE | TENTION | | -99 | -99 | 5 | | 1 | 0 | |
| 23 | 33 | PlanterBox_Ave | | BIORE | TENTION | | -99 | -99 | 0.35 | | 1 | 0 | _ |
| 24 | 40 | WetPond | | WETP | OND | | -99 | -99 | 25 | | 1 | 0 | _ |
| 25 | 41 | StormWaterWetla | ind | WETP | OND | | -99 | -99 | 10 | 1 | 1 | 0 | |
| | ▶ BN | IP_LanduseMatrix BM | IP_Trains 715_B | MPDef | 725_ClsABMPParm | า 7 | '30_Cistern | Control | 35_ClsBBMP | Parm 🕀 | : 4 | | |
| READ | Y | | | | | | | | = | <u> </u> | | + 1 | 20% |

BMP Tool – Optimization

- SUSTAINOPT provides two optimization methods:
- Scatter Search
 - Single objective seeks to identify a unique optimal solution for multiple reduction targets
 - Proved ineffective for BMP Tool's requirements (code deficiencies noted in limiting optimization run time)
- Non-dominated Sorting Genetic Algorithm II (NSGA-II)
 - Multi-objective generates Cost Effectiveness (CE) curve of optimal solutions
 - Based on a single "limiting" constituent
 - Allows for substantial computational efficiency using CEV approach
 - Explores full solution space, providing greater understanding of cost/benefit trade-offs



Cost Effective Curves





Running Enhanced BMP Tool

| A Run SUSTAINOPT |
|---|
| Specification File E:\BMPtool\Salado Ex-SUB010-P0001\SaladoCreek_HSPF10_108_over_try162_hourly.bmpspec.xlsx |
| SUSTAINOPT Input Folder E:\BMPtool\SaladoEx-SUB010-P0001\SaladoCreek_HSPF10_108_over_try162_hourty_Run |
| 100_P_104-BioSwale-P_104: Number of units=0; Area = 0ac 100_P_110-BioSwale-P_110: Number of units=2; Area = 4ac 101_103-VegetatedSwale-1_03: Number of units=1; Area = 2ac 101_P_101-VegetatedSwale-109: Number of units=0; Area = 0ac 101_P_101-VegetatedSwale-P_101: Number of units=3; Area = 6ac 101_P_102-VegetatedSwale-P_102: Number of units=45; Area = 16ac 101_P_103-VegetatedSwale-P_103: Number of units=45; Area = 90ac 101_P_104-VegetatedSwale-P_103: Number of units=45; Area = 90ac 101_P_1104-VegetatedSwale-P_103: Number of units=1; Area = 2ac |
| Costs BIORETENTION: \$2,688,600 (51 BioRetentionBasin_Ave; 2536 BioRetentionBasin_Small; 17 BioRetentionBasin_Large; 230 PlanterBox_Ave) WETPOND: \$608,440 (3 WetPond; 6 StormWaterWetland; 18 WetVaults) CISTERN: \$227,290 (131 Cistern_Ave) DRYPOND: \$108,280 (8 DryPond_Ave; 3 ExtendedDetention_Small; 0 ExtendedDetention_Ave; 0 ExtendedDetention_Large; 2 StreetSweep_, INFILTRATIONTRENCH: \$4,778,800 (21 InfiltTrench; 21 SandFilter; 12 InfiltBasin) GREENROOF: \$1.382,200 (175 GreenRoof_Ave) POROUSPAVEMENT: \$654,120 (44 PorousPavement_Ave) RAINBARREL: \$1.348.1 (124 RainBarrel_Ave) REGULATOR: \$2,250,900 (24 VortexSep_Small; 1 VortexSep_Large; 745 CatchBasinIns_Ave) SWALE: \$944,860 (60 BioSwale; 58 VegetatedSwale) Total Cost \$13,645,000 |
| Not all reduction tar Finished running SUSTAINOPT |
| |
| Solutions per Excee Ran SUSTAINOPT for 1 subbasin. |
| Ok |



Running Enhanced BMP Tool

| Specification File | E-\BMPtool\SaladoEx-SUB010-P0001\SaladoCreek_HSPE10_108_over_trv162_bourdy.bmpspec.vlex | |
|---|---|-----------|
| SUSTAINOPT Input Folder | E:\BMPtool\SaladoEx.SUB010-P001\SaladoCreek_HSPF10_108_over_try162_hourty_Run | |
| Enhanced BMP Tool softw 1 of 1 selected subbasins in HSPF run: WinHSPR zwe HSPF Output Rowweight Enhanced BMP Tool SE Enhanced BMP Tool SE Enhanced BMP Tool SA Enhanced BMP Tool PB Load Reduction Tool PB Load Reduction Tool CB Enhanced BMP Tool CD Enhanced BMP Tool CD Enhanced BMP Tool CD Enhanced BMP Tool CD Load Reduction Tool CB | are version 1/29/2015, report date 2/4/2015 5:41:35 PM notified for HSPF nm EXBMPtool/SaladoCreek_UBD10-P0001/SaladoCreek_HSPF10_108_over_try162_hourly_Run/SaladoCreek_HSPF10_108_over_try162_hourly d concentrations for Subbasin 10 0 = 250 0 = 250 27 = 57.92 CT = 57.92 CT = 126 = 1:3049 = 02 = 10.35 = 5 = 00 = 4.7295 OD = 4.7295 OD = 2 | .SEBT.uci |
| Solutions per Exceedance | to run for entire period: 20 | |
| _ | | |
| | HSPE run Complete | 52 |







BMP Implementation Strategies



Awards and Recognitions

- WEF Project Excellence Award (2020)
- ACEC Texas Gold Medal Award (2016)
- ACEC National Recognition Award (2016)
- Numerous presentations (invited and conference), publications and magazine articles

Questions? Contact: Sheeba M Thomas Dominguez <u>sthomas@sariverauthority.org</u> 210-302-4290

