Regional Simulation Model (RSM)
Benchmark Guide

RSM Version 2.2.9

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Chapter 1

Introduction To RSM Benchmarks

Welcome to the South Florida Water Management District's (SFWMD) Regional Simulation Model (RSM). The RSM is a general hydrologic computer model developed over the past 10 years by the SFWMD in West Palm Beach, Florida. RSM is capable of simulating a wide range of hydrologic conditions, although it has been developed principally for application in South Florida. The RSM is developed on a sound conceptual and mathematical framework that allows the RSM to be applied in a wide range of hydrologic situations.

The RSM simulates the coupled movement and distribution of groundwater and surface water throughout the model domain. The RSM currently has two principal components including the Hydrologic Simulation Engine (HSE) and the Management Simulation Engine (MSE). The HSE is capable of simulating the natural hydrology, water control features, water conveyance systems and the storage systems of South Florida. The HSE solves the governing equations of water flow through both the natural hydrologic system and man-made structures. Future versions of RSM will also be able to simulate water quality. The MSE allows water management functionality to applied to HSE simulations.

During the model development life-cycle, the RSM model has been continually tested against a series of benchmark test cases. These test cases have expanded over time as more functionality has been added to the model. This manual provides an overview of these test cases.

1.1 Background

The Regional Simulation Model (RSM) has been developed to provide a tool to simulate the hydrology and man-made water control features of South Florida. This model represents the next generation of integrated water management modeling and therefore contains many new features and concepts. To assure that the model is computationally sound and does not get corrupted during development, a series of benchmarks are maintained and used to test the integrity of the code over time.

These benchmarks have been designed to test all features of RSM and to provide working examples for model users. RSM objects are created in a certain sequence partly for historical reasons, and partly because of the C++ object inheritance present in RSM. Therefore, the data set sequence is important because certain objects can be created only after other objects are created. It is safe to follow the XML data input ordering contained in the RSM benchmarks to eliminate errors related to the ordering of the XML data. The first-order elements beneath the root element `<hse>` (see Figure 1.1) are sequenced in the benchmarks as shown in Figure 1.2 and Figure 1.3. Because RSM is such a flexible model, the sequencing depicted in these tables does vary, so it is best to pick a benchmark example that is similar to your problem and use the benchmark as a guide to building your input files.

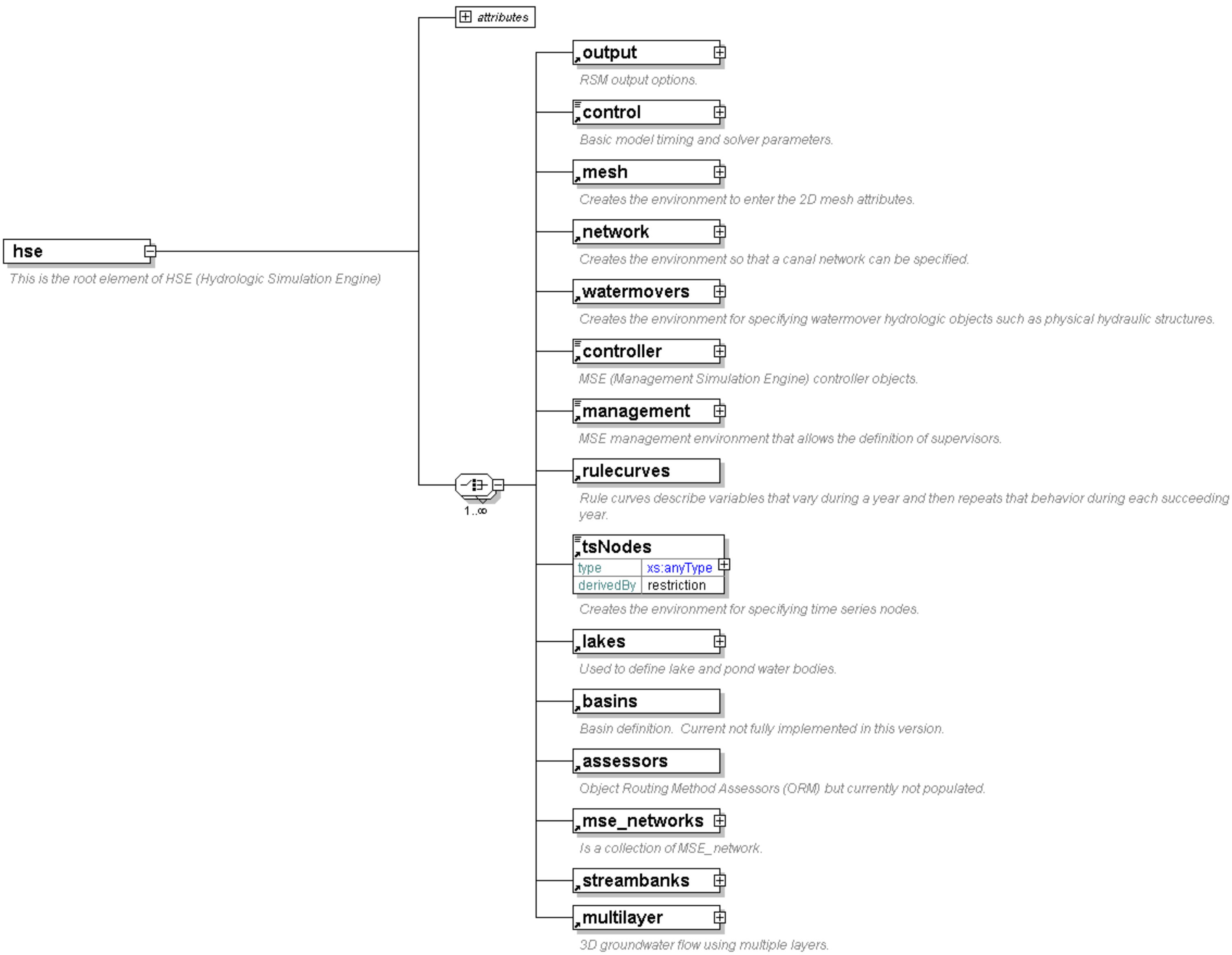

Figure 1.1: *The HSE root node and first-order children elements.*

Benchmark Number »	1	2	3	4	5	6	7	8	9	10
Filename »	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml
assessors										
basins										
control	1	1	1	1	1	1	1	1	1	1
controller										
lakes										
management										
mesh	2	2		3	2	2	2	2	2	3
mse_networks										
multilayer										
network			2	2					3	2
output	3	3	3	4	4	3	3	3	5	4
rulecurves										
streambanks										
tsNodes										
watermovers					3				4	

Benchmark Number »	11	12	13	14	15	16	17	18	19	20
Filename »	pinder.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml
assessors										
basins										
control	1	1	1	1	1	1	1	1	1	1
controller										
lakes			3							
management										
mesh	3	2	2	3	2	2	2	2	2	3
mse_networks										
multilayer										
network	2			2						2
output	4	3	5	5	3	3	3	3	3	5
rulecurves										
streambanks										
tsNodes										
watermovers			4	4						4

Benchmark Number »	21	22	23	24	25	26	27	28	29	30
Filename »	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	Depricated	run3x3.xml	enpinput.xml
assessors										
basins										
control	1	1	1	1	1	1	1		1	1
controller										
lakes										
management										
mesh	3	3	3	2	2	4	3		2	3
mse_networks										
multilayer										
network	2	2	2			2	2			2
output	5	5	5	3	3	5	4		3	4
rulecurves										
streambanks										
tsNodes										
watermovers	4	4	4			3				

Benchmark Number »	31	32	33	34	35	36	37	38	39	40
Filename »	enpinput.xml	run3x3.xml	run3x3.xml	18input.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml & run3x3_gweir.xml
assessors										
basins										
control	1	1	1	1	1	1	1	1	1	1
controller										4
lakes										
management										
mesh	3	2	2	2	2	2	2	2	2	
mse_networks										
multilayer									3	
network	2			3						2
output	4	3	3	4	3	3	3	3	4	5
rulecurves										
streambanks										
tsNodes										
watermovers										3

Figure 1.2: *Part 1 of 2: The order of occurrence of all first-order elements used in Benchmarks 1 to 40.*

Benchmark Number »	41	42	43	44	45					46
Filename »	run3x3.xml	run3x3.xml	fuzctrl_hq_scalar.xml & fuzctrl_hq_vector.xml	run3x3.xml	run3x3.xml	user_C_ctrl.xml	user_C_supervise.xml	user_F_ctrl.xml	usersupervise.xml	kala.xml
assessors										
basins										
control	1	1	1	1	1	1	1	1	1	1
controller	4		4		4	4	4	4	4	
lakes										4
management							5	.	5	
mesh		3		2						2
mse_networks										
multilayer										
network	2	2	2	3	2	2	2	2	2	3
output	5	4	5	4	5	5	6	5	6	6
rulecurves										
streambanks										
tsNodes										
watermovers	3		3		3	3	3	3	3	5

Benchmark Number »	47	48	49	50	51	52	53	54	55	56
Filename »	run3x3.xml	graphSpvr.xml	mseNetworkSpvr.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml	run3x3.xml
assessors			7							
basins										
control	1	1	1	1	1	1	1	1	1	1
controller	5	6	8							
lakes			5							
management	6	7	9							
mesh	3	4	4	2	2	3	2	2	3	2
mse_networks										
multilayer										
network	2	3	3			4			4	
output	7	8	10	3	3		3	3		3
rulecurves		2	2			2			2	
streambanks										
tsNodes										
watermovers	4	5	6							

Benchmark Number »	57	58	59	60	61	62	63			
Filename »	run3x3.xml	lakes.xml	levee.xml	trigtest.xml	run3x3.xml	eaa-miani.xml	floodroute.xml	seasonroute.xml	seasonalpc.xml	supvfloodroute.xml
assessors					6	9		6	6	6
basins						4				
control	1	1	1	1	1	1	1	1	1	1
controller						7		7	7	7
lakes		2				5	5	5	5	5
management				4		8				
mesh	3		3	3	3		4	4	4	4
mse_networks										
multilayer										
network	2				5		3	3	3	3
output	4	3	4	5	7	10	7	9	9	9
rulecurves			2	2	2	2	2	2	2	2
streambanks										
tsNodes						3				
watermovers					4	6	6	8	8	8

Benchmark Number »	63	64
Filename »	supvfloodroute.xml	run3x3.xml
assessors	6	
basins		
control	1	1
controller	7	
lakes	5	
management		
mesh	4	2
mse_networks		
multilayer		
network	3	
output	9	3
rulecurves	2	
streambanks		
tsNodes		
watermovers	8	

Figure 1.3: *Part 2 of 2: The order of occurrence of all first-order elements used in Benchmarks 41 to 64.*

Chapter 2

Model Validation Benchmarks And Test Cases

Complete descriptions of all benchmarks can be individually accessed with hyperlinks as shown in Table 2.1 [1]. For user's wanting a complete benchmark guide, a complete listing of all benchmarks can be obtained here[2].

The benchmarks use a variety of meshes to simulate the test cases. Many of the cases are solved using the 3x3 finite volume mesh is shown in Figure 2.1. Several cases use this same grid, but with a canal superimposed on the mesh as shown in Figure 2.2. Five additional meshes have been developed for different cases. These meshes are shown in Figure 2.3, Figure 2.4, Figure 2.5, Figure 2.6, and Figure 2.7.

[1]http://gwmftp.jacobs.com/benchmarks/BM1/BM1.pdf, for example
[2]http://gwmftp.jacobs.com/benchmarks/bm_des.pdf

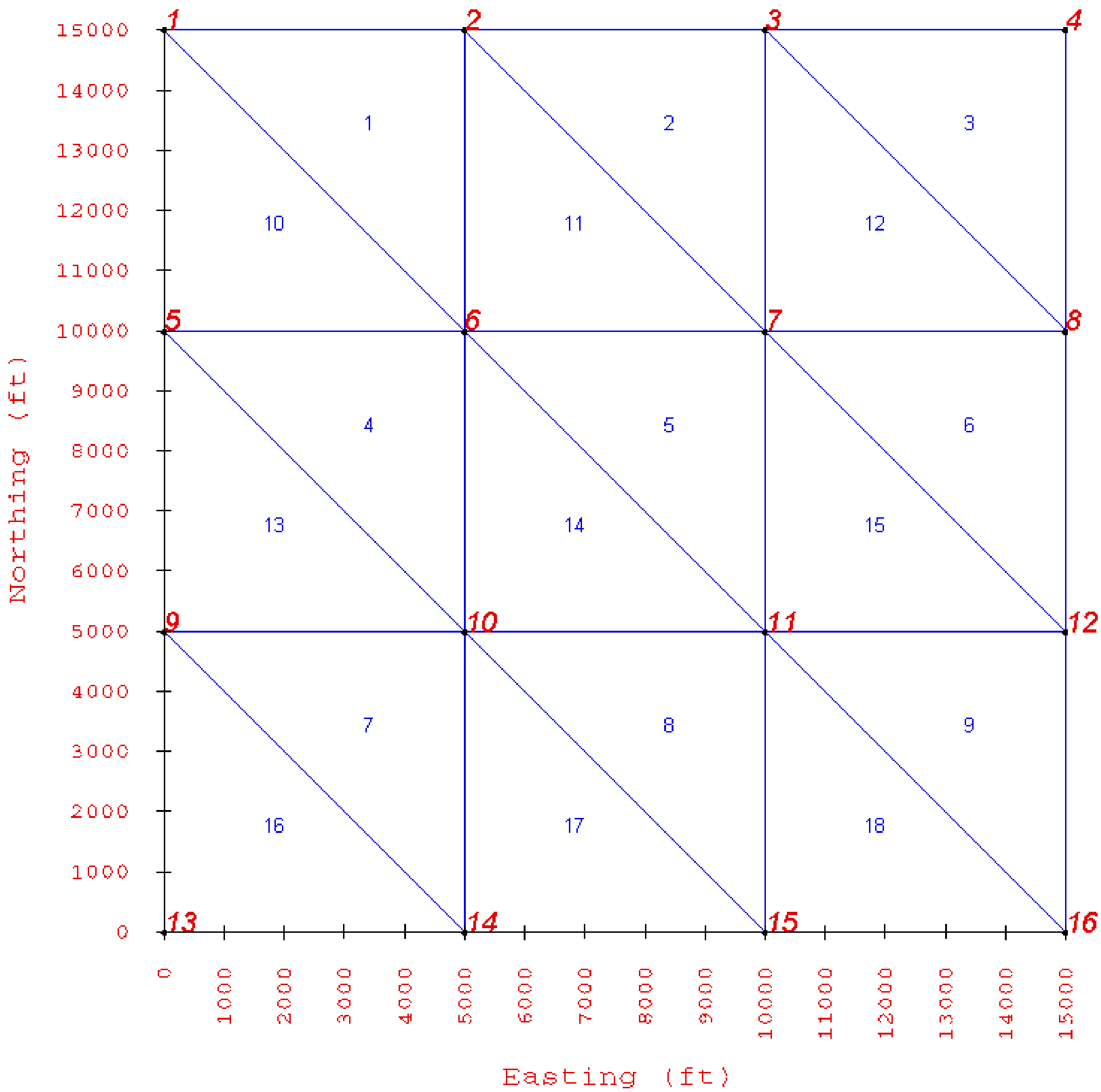

Figure 2.1: *3x3 finite-volume mesh used for many of the benchmarks listed in Table 2.1.*

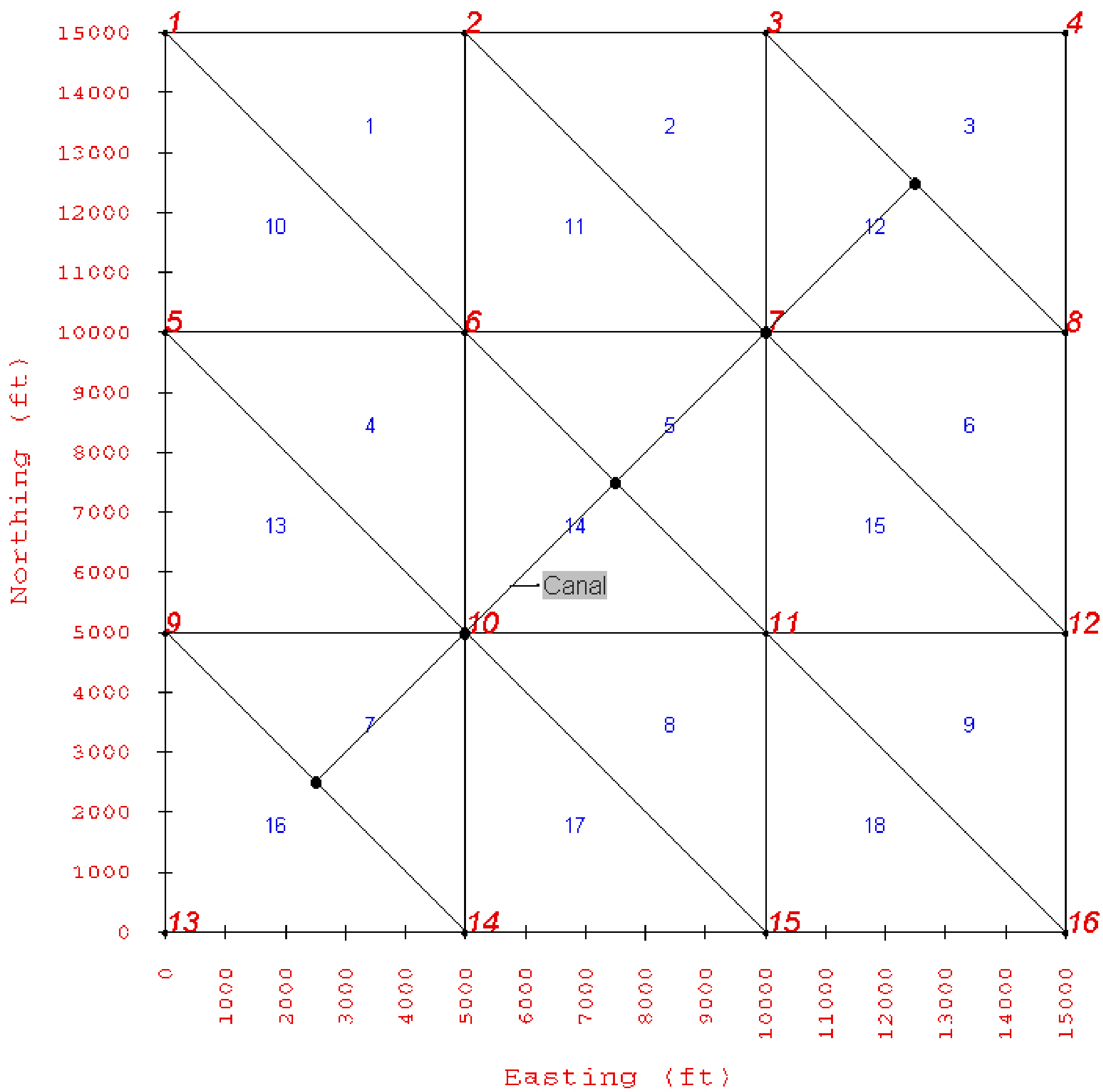

Figure 2.2: *3x3 finite-volume mesh with canal used for many of the benchmarks listed in Table 2.1.*

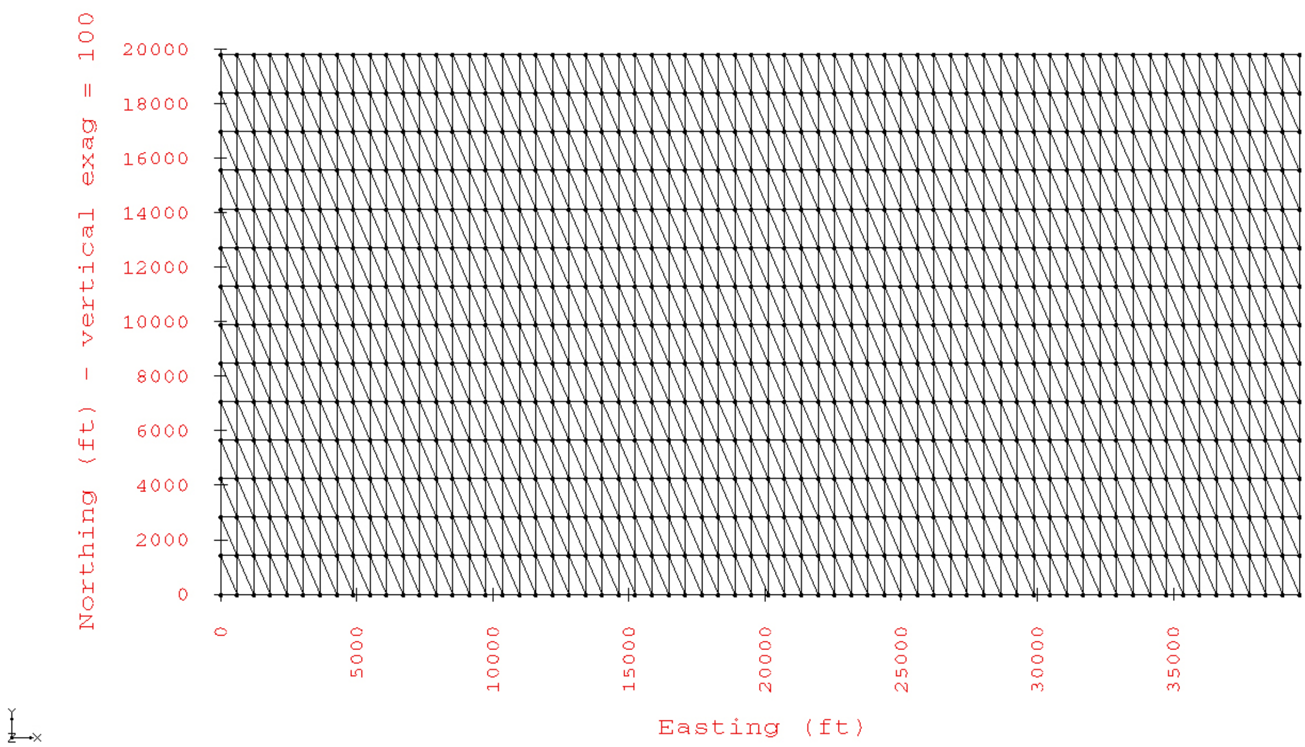

Figure 2.3: *Pinder finite-volume mesh used for benchmark 11 in Table 2.1.*

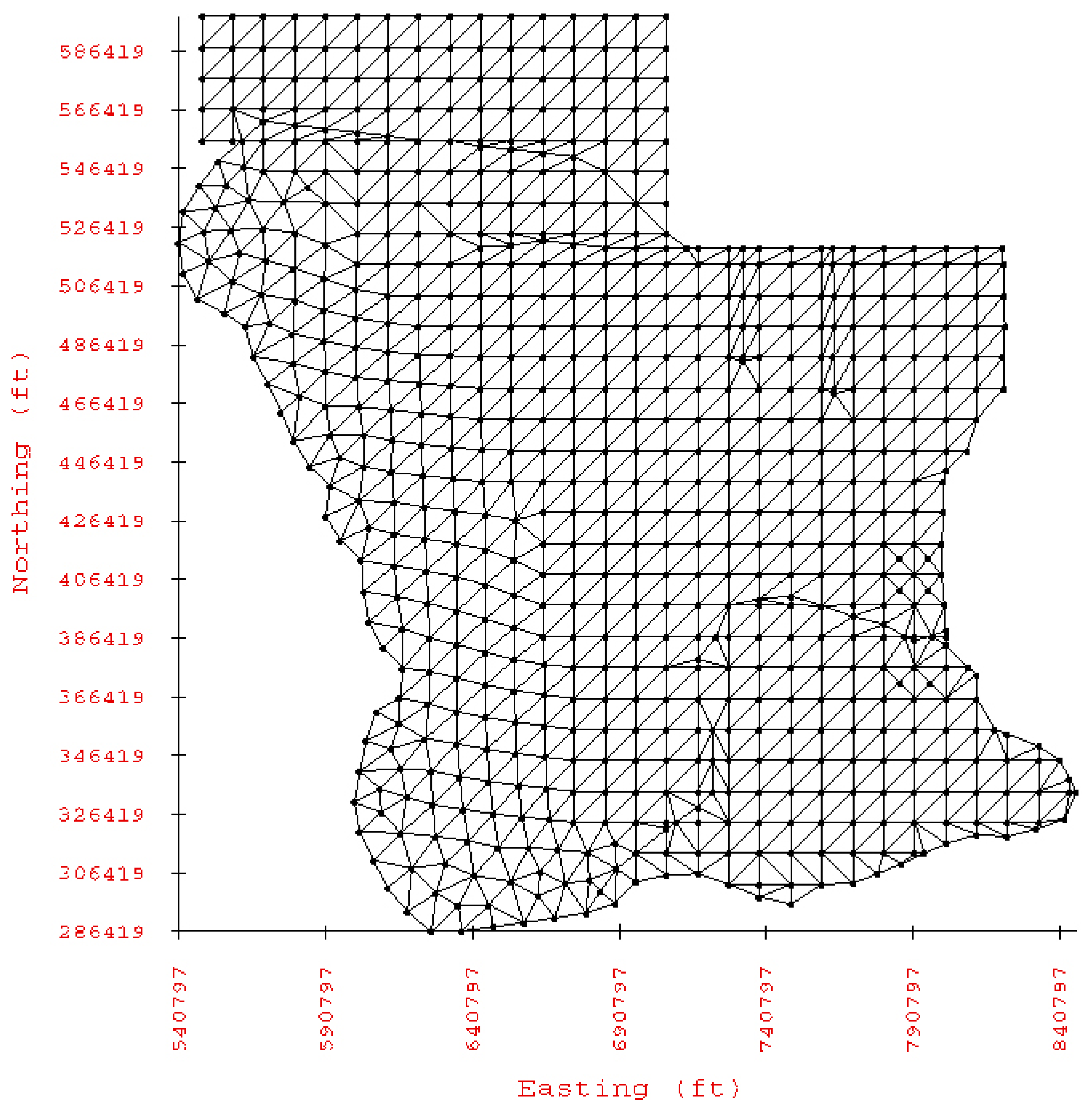

Figure 2.4: *Everglades National Park finite-volume mesh used for benchmarks 30 and 31 listed in Table 2.1.*

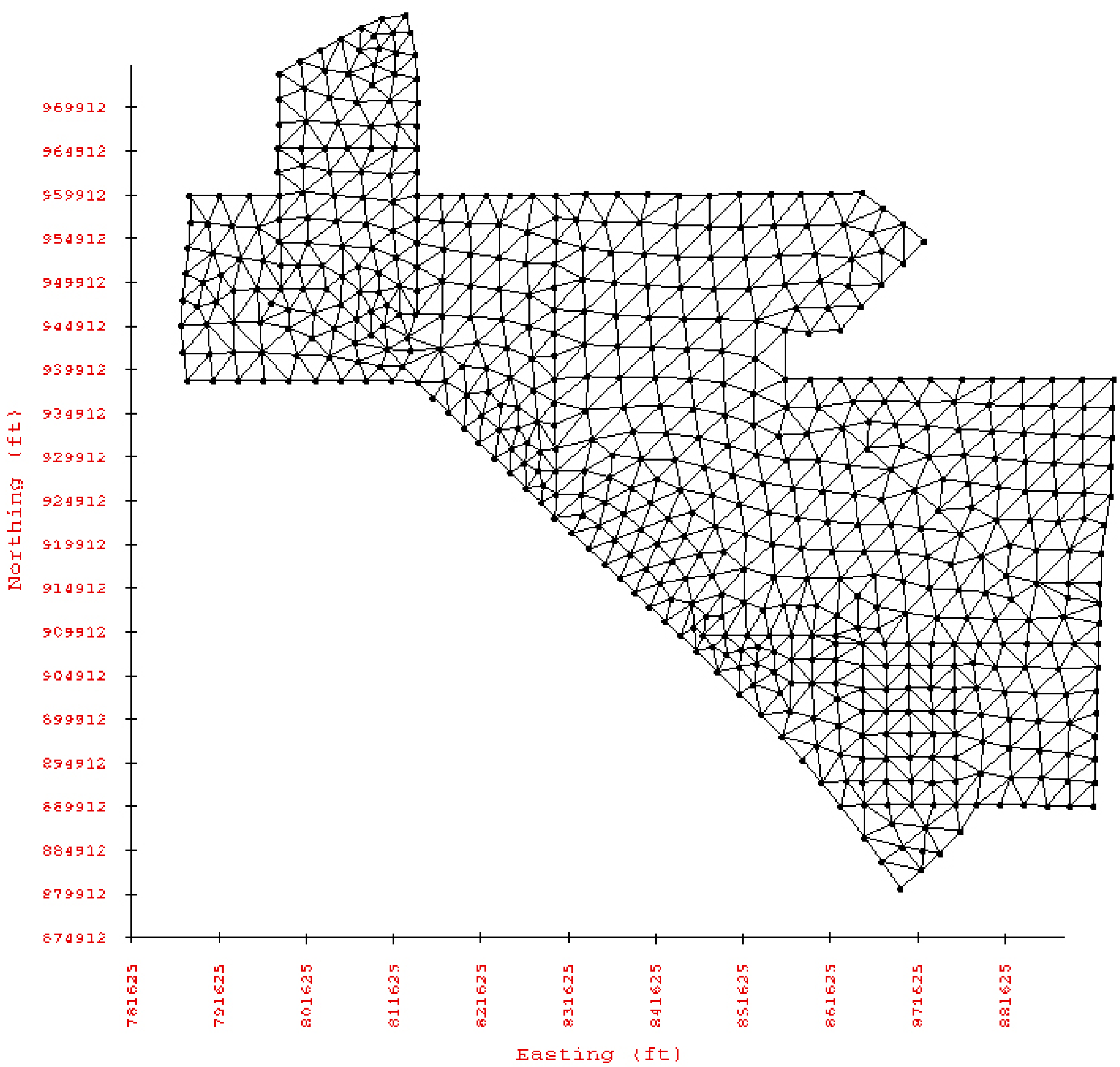

Figure 2.5: *L8 finite-volume mesh with canal used for benchmark 34 listed in Table 2.1.*

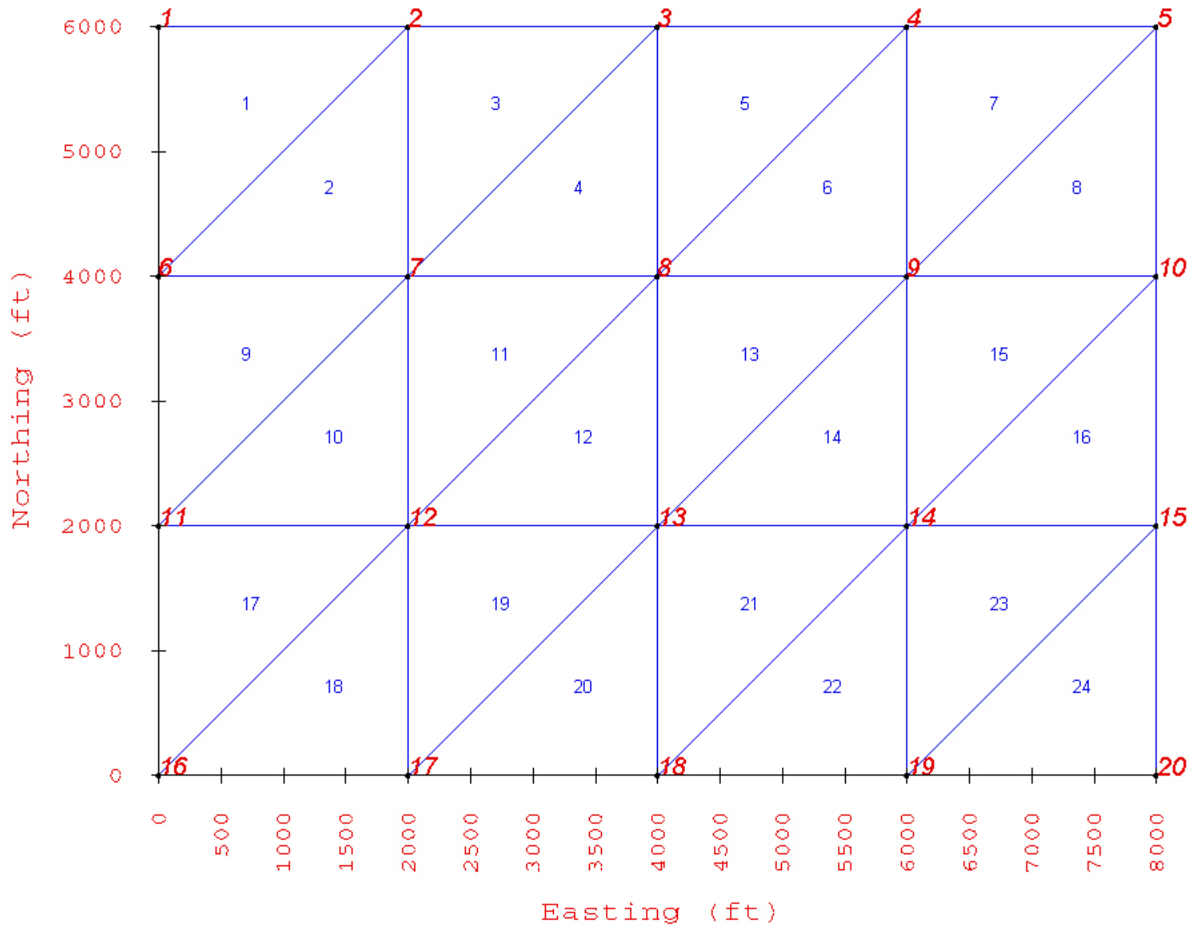

Figure 2.6: *3x4 finite-volume mesh used for bermseepage in benchmark 59 listed in Table 2.1.*

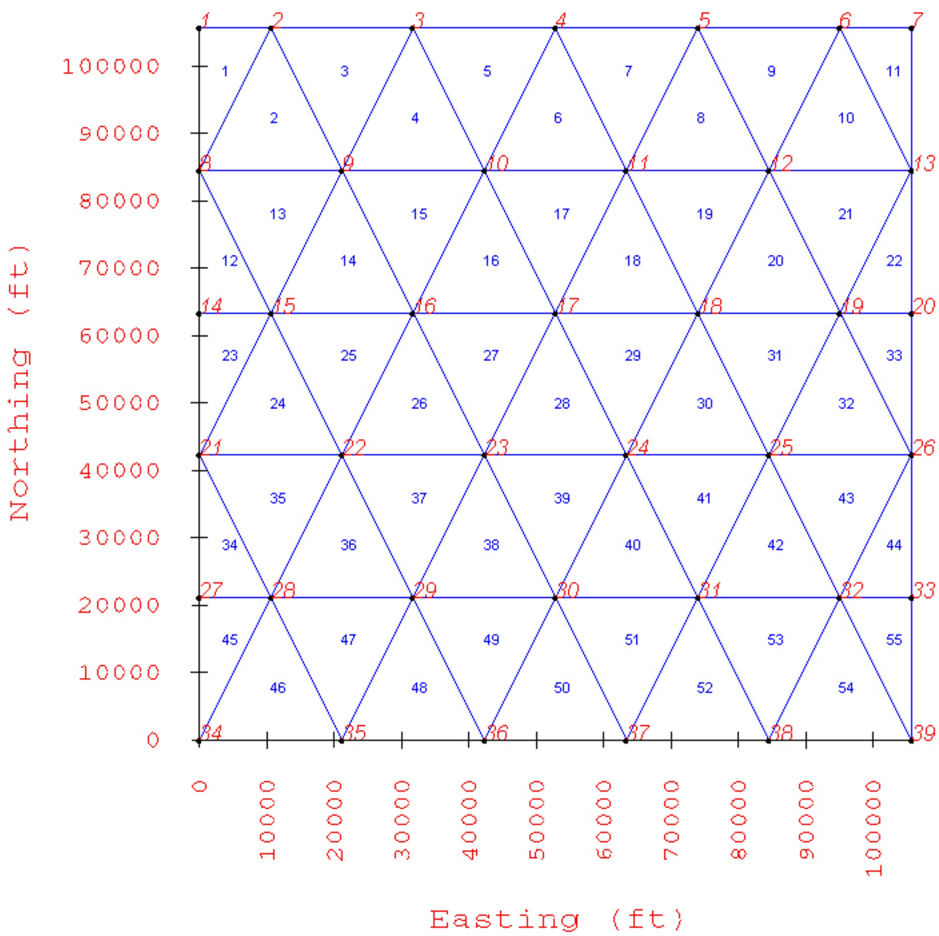

Figure 2.7: *5x6 finite-volume mesh used for routing in benchmark 63 listed in Table 2.1.*

Table 2.1: *Benchmarks established for the HSE, hyperlinks yield full descriptions*

Hyperlink	Mesh/Network	Feature Tested
BM1	Figure 2.1	Overland flow
BM2	Figure 2.1	Overland and groundwater flow
BM3	Figure 2.2	Canal flow
BM4	Figure 2.2	Overland flow, gw flow, canal flow, and streambank.
BM5	Figure 2.1	Single_control watermovers
BM6	Figure 2.1	Steady state solution
BM7	Figure 2.1	Pumping wells
BM8	Figure 2.1	5-layer HPM
BM9	Figure 2.2	Dual_control watermover
BM10	Figure 2.2	Head boundary conditions
BM11	Figure 2.3	GW flow, canal flow and mesh to canal interaction
BM12	Figure 2.1	General head boundary conditions
BM13	Figure 2.1	Lakes and ponds
BM14	Figure 2.2	Culverts
BM15	Figure 2.1	Indexed entry of HPMs
BM16	Figure 2.1	Nsm1layer HPM, w/ampmod feature
BM17	Figure 2.1	Svconverter lookup table
BM18	Figure 2.1	Unsat HPM
BM19	Figure 2.1	Output options, including netcdf
BM20	Figure 2.2	Single_control watermover (segment h20)
BM21	Figure 2.2	Single_control watermover (cell h20)
BM22	Figure 2.2	MBR pipes
BM23	Figure 2.2	Three MBR weirs
BM24	Figure 2.1	Indexed entry of rain and refet
BM25	Figure 2.1	Mbrcell HPM
BM26	Figure 2.2	Three MBR bleeders
BM27	Figure 2.2	Canal streambank implementation
BM30	Figure 2.4	Include external files, mesh and network bc's
BM31	Figure 2.4	Separate type conveyance , like BM30
BM33	Figure 2.1	Afsirs HPM
BM34	Figure 2.5	Wts2pt wallhead, various conveyance formulations
BM35	Figure 2.1	General head boundary imposed on walls
BM36	Figure 2.1	Lookup tables for conveyance and transmissivity
BM37	Figure 2.1	Lookup table for soil storage coefficient
BM38	Figure 2.1	Kadlec formulation for conveyance

Table 2.1 continued on next page

Hyperlink	**Mesh/Network**	**Feature Tested**
BM40	Figure 2.2	Pidctrl controllers
BM41	Figure 2.2	Setpointctrl controllers
BM42	Figure 2.2	GHB boundary conditions
BM43	Figure 2.2	Fuzctrl controllers
BM44	Figure 2.2	Upwind methods in overland and canal flows
BM45	Figure 2.2	User Defined controller
BM47	Figure 2.1	GLPK optimization problem
BM48	Figure 2.1	MSE network rep. and HSE to MSE network mapping
BM49	Figure 2.1	MSE network rep. and HSE to MSE network mapping
BM50	Figure 2.1	HPM hub
BM51	Figure 2.1	Impervious HPM
BM52	Figure 2.1	Urbandet HPM with transient wallhead bc's
BM53	Figure 2.1	Urbanhub HPM with urbanhub feature
BM54	Figure 2.1	Urbanhub runoff and wsuppy routing
BM55	Figure 2.1	Urbanhub consumptive use and return flow
BM56	Figure 2.1	Precipitation runoff model (nam or prr) HPM
BM57	Figure 2.1	One2many, pumpedditch and agimp
BM58	Figure 2.1	Lake boundary conditions
BM59	Figure 2.6	Berm seepage
BM60	Figure 2.1	Trigger module
BM61	Figure 2.1	Wave propagation in a canal and mesh
BM62	Figure 2.1	ORM supervisor
BM63	Figure 2.7	Flood routing, water supply, seasonal routing and supervisors
BM64	Figure 2.1	Tests arcverticies to define canal segment shape