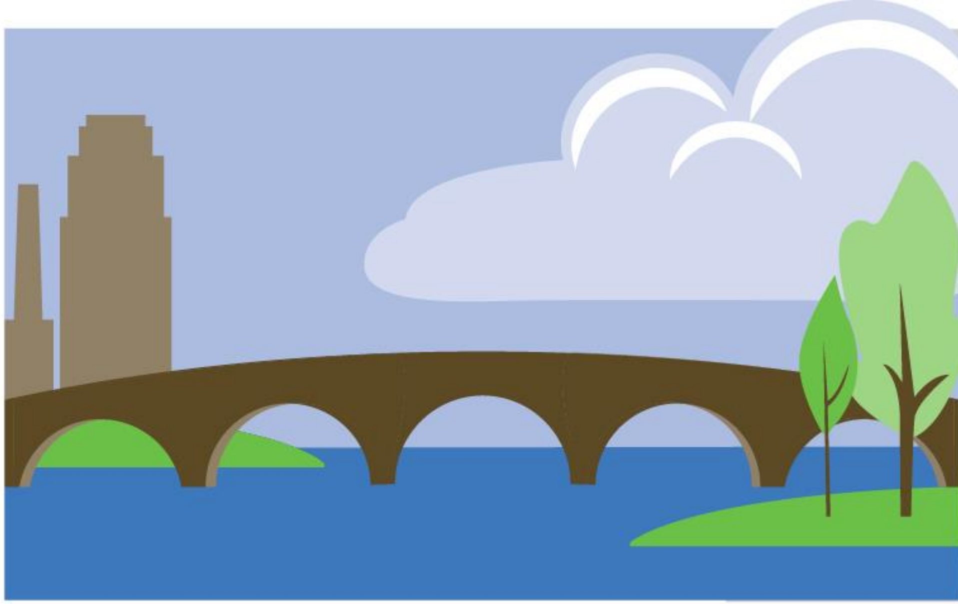

CONNECTING THE BUILT AND NATURAL ENVIRONMENT

ASIC | 2015 | MINNEAPOLIS | MINNESOTA

Irrigation Codes and Standards and How They Impact You

CONNECTING THE BUILT AND NATURAL ENVIRONMENT

CLICK HERE TO INSERT

Brent Mecham, Brian Vinchesi

Market Transformation

Voluntary

- **BMPs**
- **Standards**
- **Green Initiatives**
- **Consumer Expectations**

Mandatory

- Ordinances
- Codes
- Executive Orders

Irrigation BMPs

- Collaboration between ASIC & IA
- BMP & Practice Guidelines
  – Design
  – Installation
  – Management
- Appendices
  – Inspection & Commissioning
  – Water Budgeting
  – Scheduling


IRRIGATION ASSOCIATION & AMERICAN SOCIETY OF IRRIGATION CONSULTANTS

Landscape Irrigation Best Management Practices

May 2014

Prepared by the Irrigation Association and American Society of Irrigation Consultants

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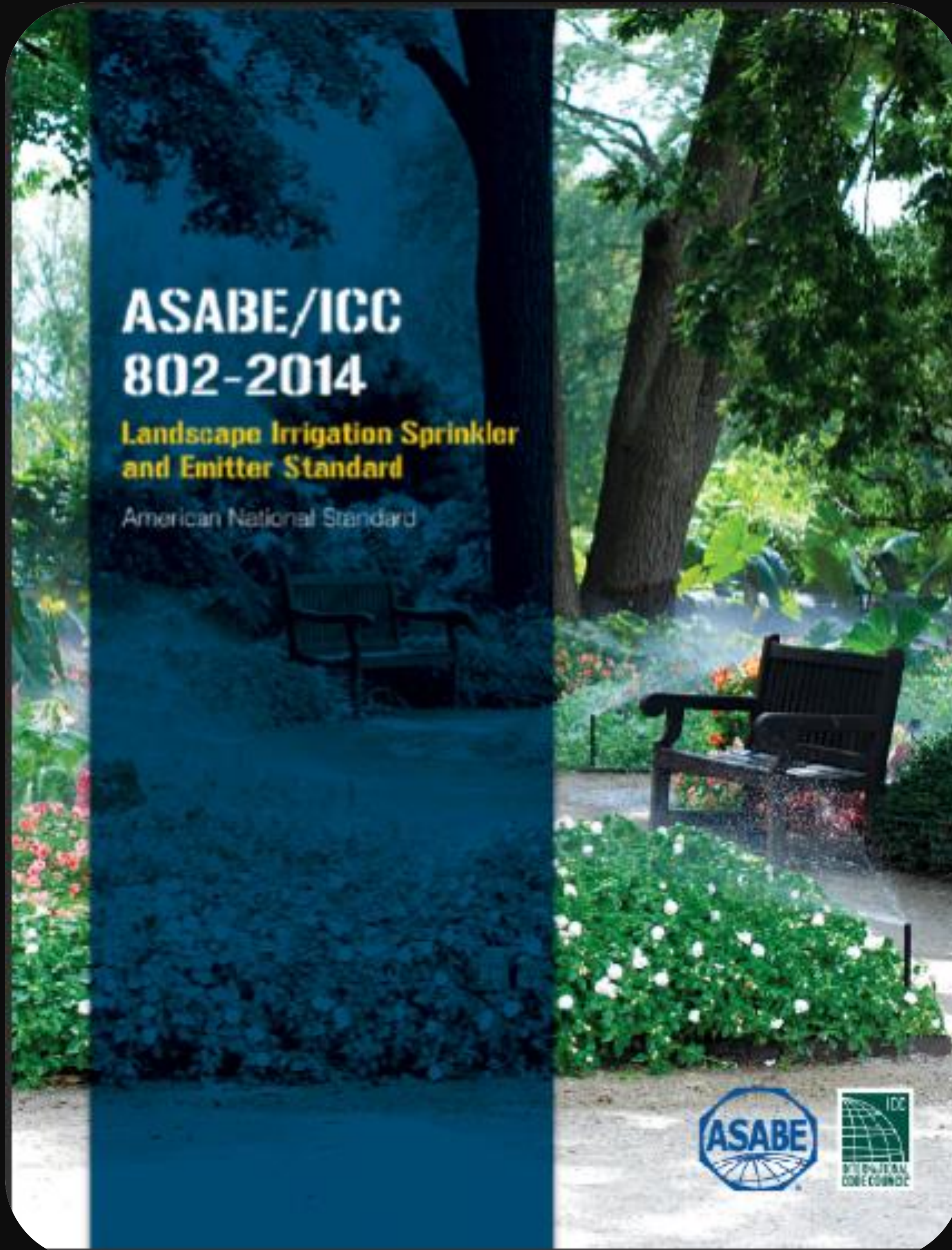
The Irrigation Association and the American Society of Irrigation Consultants have developed the *Landscape Irrigation Best Management Practices* for landscape and irrigation professionals and policy makers who must preserve and extend the water supply while protecting water quality. The BMPs will aid key stakeholders (policy makers, water purveyors, designers, installation and maintenance contractors, and consumers) to develop and implement appropriate codes and standards for effective water stewardship in the landscape.


ASABE/ICC
802-2014
Landscape Irrigation Sprinkler
and Emitter Standard
American National Standard
ASABE
ICC

ASABE/ICC 802—2014 Landscape Irrigation Sprinkler and Emitter Standard

Definitions

Tests—Sprinklers & Bubblers

- Flow Rate
- Distance of Throw
- Distribution Uniformity
- Burst Pressure
- Check Valve
- Pressure Regulation

ASABE/ICC 802—2014 Landscape Irrigation Sprinkler and Emitter Standard

Tests—Emitters and Microsprays

- Uniformity of flow rate
- Flow rate as a function of pressure
- Emitter exponent for PC emission devices
- Check valve function

Standardized Procedure for Determining Landscape Plant Water Demands

Annual Average Fraction of ET_O

Plant Type	Plant Factor
Turf – Cool Season	0.8
Turf – Warm Season	0.6
Annual Flowers	0.8
Woody plants, herbaceous perennials—Wet* (> 20 inches of precipitation)	0.7
Woody plants, herbaceous perennials—Dry*	0.5
Desert plants (< 10 inches of precipitation)	0.3

ASABE X626

- Measuring Irrigation Performance
  - Catch Can Tests
  - Drip Evaluation
  - Soil Moisture Tests
- Commissioning

ASABE X633 and X627

- Soil Moisture Sensors
  - Sensor Only
  - Beta Testing
- Environmentally Responsive Controllers
  - Weather Based Only

SWAT vs. EPA WaterSense Labeling

- If you have one should you get the other?
  - How?


Green Codes

Green Codes

- Supplement or overlay other building codes and enforceable
- "Greener" way of building
  - Energy efficiency
  - Water efficiency
  - Indoor environment
- Go outside of the building envelope
  - Site requirements
  - Landscape & irrigation requirements

ASHRAE 189.1

- ASHRAE 189.1-2014 Standard for the Design of High-Performance Green Buildings
  - 40% turf limitation in the water efficiency section
  - Irrigation provisions
    - Hydrozoning
    - Controllers—SWAT posted 80% / 10%
    - 33% of landscape can use potable water or
    - 35% of total landscape water can be potable or municipally reclaimed water
      - 70% ET_o for turf, 55% ET_o for plantings
  - Meters > 25,000 s.f. or 1000 gal/day (potable)

IgCC-2015

- Reduce potable water use by 50%
  - Unless allowed by AHJ
- Design and installation by accredited or certified professional
- Controller regulates based on weather or soil moisture
- Rain sensor
- Hydrozoning
- Pressure regulation for drip is 40 psi or less

IgCC-2015

- Sprinklers shall:
  - MPR
  - Prohibited in area less than 4 feet
  - Prohibited on slopes greater than 25%
    - Except if PR is less than 0.50 in./h
  - Sprinklers on turfgrass only
  - 4 inch pop up minimum
  - DU_{lq} not less than 0.65

IgCC-2015

- Alternate water sources
- Rainwater systems no limit on method
- Graywater systems subsurface only and storage maximum 24 hours
- Signage & equipment marking requirements
- Water quality testing requirements
- Metering potable and nonpotable water required if there is a controller

LEED v4

- Understanding that what they say is not the same as what they mean.
- Water really means potable water.
- Maximum points for harvesting water for irrigation.

News brief

- ASHRAE 189.1, IgCC, LEED, AIA are merging efforts.
- Minimize duplication and overlap.
- LEED picks up where the standard ends.


IAPMO
Green Technical Supplement

Green Supplement-2012

- Backflow for potable and reclaimed
- Designed to use minimum 75% of alternate water for annual demand.
- Control system
  - WBIC or SMS
  - Rainfall and soil moisture suspension
  - Cycle & Soak
  - Post irrigation controller settings
    - PR
    - Plant factors
    - Sensor settings
    - Peak demand schedule

Green Supplement-2012

- Low Flow Irrigation
  - Pressure regulation appropriate for emission devices
  - Required for vegetation over 12 inches in height
- No runoff out of zone
- No low-head drainage
- No off target application
- Prohibited on narrow areas less than 4 feet
- Sloped areas maximum 0.75 PR

Green Supplement-2012

- Sprinklers-low precipitation rate
- Sprinklers have MPR
- Sprinklers shall have pressure regulation
  - At the valve or the sprinkler
- Sprinklers shall pop up at least 4 inches
- Sprinklers shall not exceed 1 in./h
- Catch can test (6 cans for 15 minutes)
- Competent designers and contractors shall be certified to perform the work

2015 additional provisions

- Dedicated meter for landscapes > 1,500 s.f. with controller (2,500 s.f. w/o controller)
- Meter for vegetated roofs > 300 s.f.
- Maximum velocity for irrigation is 5 fps in plastic pipes, 7.5 fps in metal pipes
- Master valve for continuously pressurized alternate water sources
- Identification when using alternate water on conversions. New areas use purple pipe.

2015 additional provisions

- Sensors to inhibit irrigation when raining or freezing conditions.
- Controls follow WaterSense specifications
- Sprinklers and Emitters comply with ASABE/ICC 802-2014 standard

2015 additional provisions

- Exception to runoff / off target application is allowed for paved walkways, paths, etc. that are outside of public right of way. Water stays within hydrozone.
- Outside hose bibs shall be allowed on irrigation pipe downstream of PBD with signage.
- Pipe bury
  - > 10,000 s.f., 18 in. for main line, 12 in. for laterals
  - < 10,000 s.f., 12 in. for main line, 8 inches for laterals
  - Vehicle surfaces in sleeve minimum 24 inches deep

News

- IAPMO GTS 2015 will be last version
  - Creating a standard about water use efficiency instead of code for easier adoption.
  - WE-Stand 2017 ANS for Water Efficiency
- Green Building Initiative
  - Working on updating the 2010 standard
- National Green Building Standard
  - Updating for 2015

Alternate Water Sources

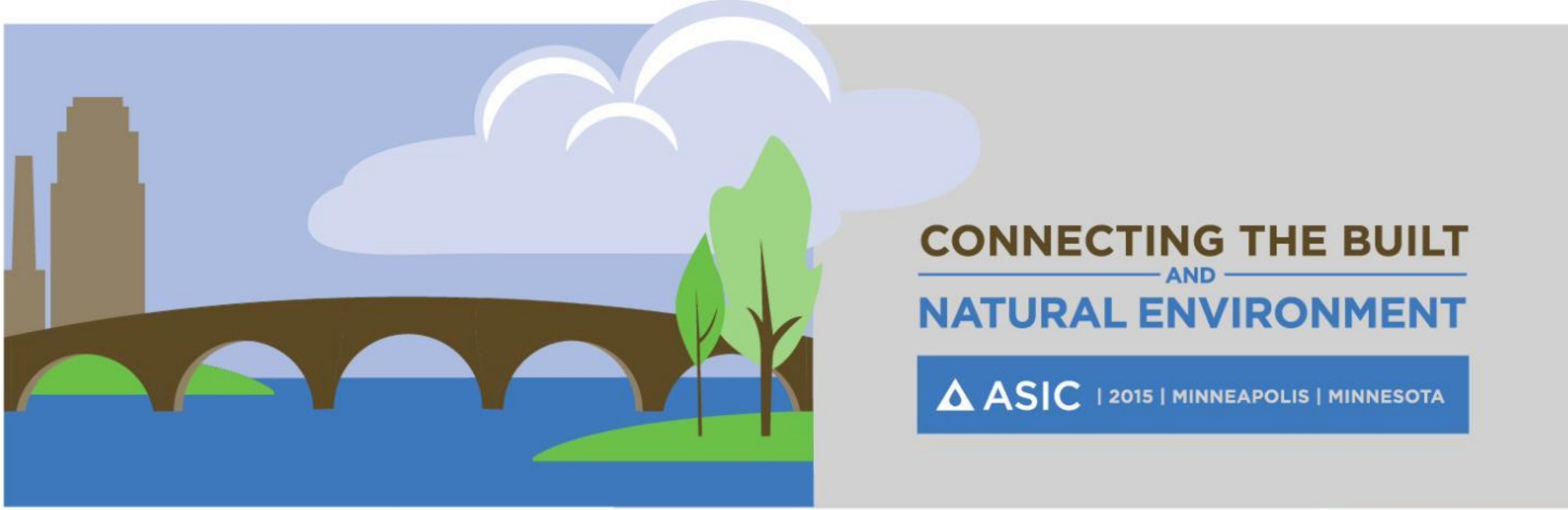
- Rainwater Harvesting Standard
  - ASPE/ARCSA 63
- Stormwater Harvesting Standard
  - ASPE/ARCSA 78

Commissioning

- ICC 1000-201X Standard for Commissioning
- 1st draft out for public comment
- Commission Providers/Specialist –certified
- Commissioning plan
- Testing & Evaluating
- Documentation, i.e. operators manual
- Report
- 3rd Party Vendor

EPA WaterSense

- Pending
  - NOI Pressure Regulating Sprinklers
  - NOI Soil Moisture Sensors



A New Way to Measure, Calculate and Use Irrigation Efficiency

CONNECTING THE BUILT AND NATURAL ENVIRONMENT

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A New Way to Measure, Calculate and Use Irrigation Efficiency

David Zoldoske,
Center for Irrigation Technology
Brent Mecham, Irrigation Association

Key Terms

- Coverage
- Distribution Uniformity
- Overspray losses
- Percolation losses
- Sprinkler Operation Efficiency
- Irrigation Efficiency

Coverage

Distribution Uniformity

Overspray

Runoff

Percolation

Keeping Water on Target

Simple

Simple

Challenging

Difficult

Spray nozzle

MSMT Rotary Nozzles

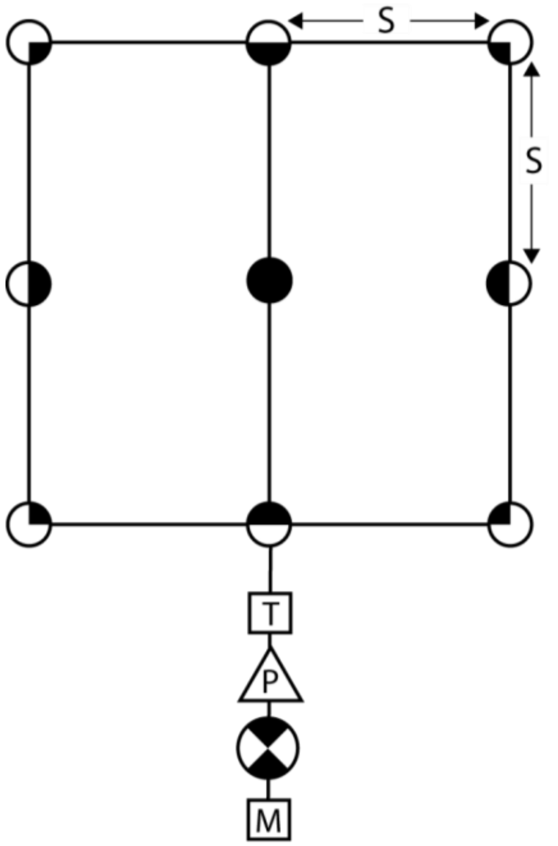
Multiple nozzle performance

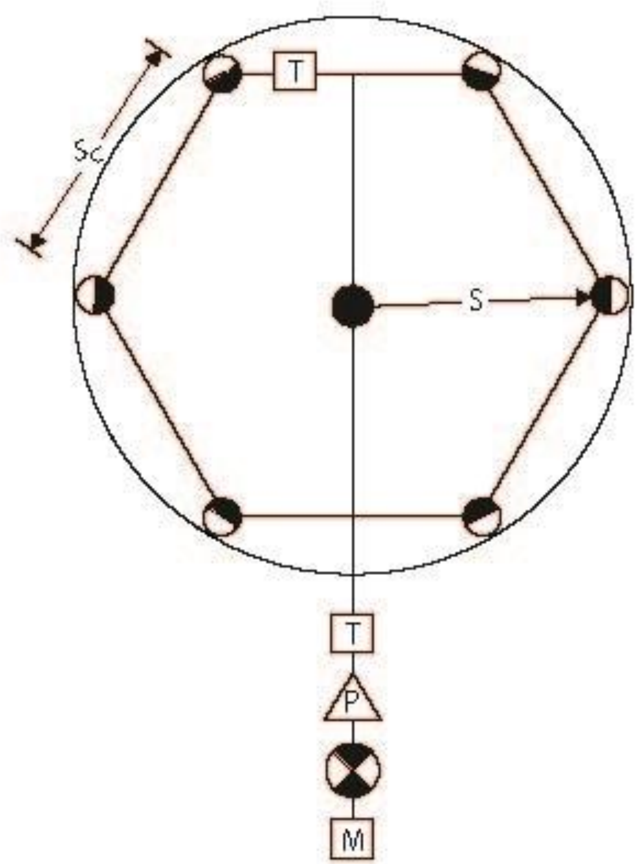
Multiple nozzle performance

SWAT Testing Protocol

- Spray Head Nozzles Performance Characteristics 3.2
  - Individual nozzles and groups of nozzles
  - Spacing configurations
  - Operating pressures
  - Repeatability
  - DU_{lq}
  - Sprinkler operational efficiency
- Finalized April, 2015—ready for testing

Testing configurations





Testing Area

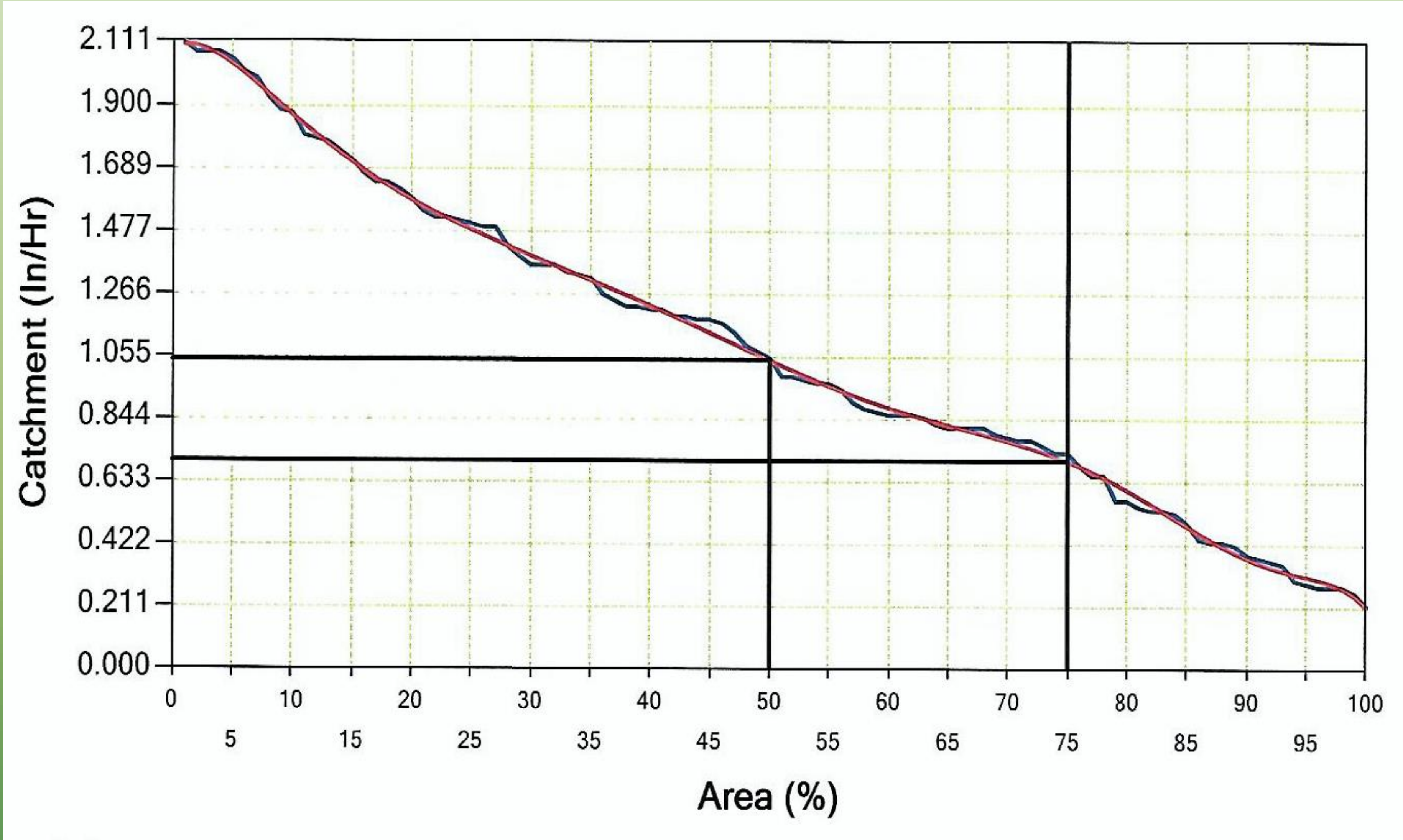
Pressure is set to manufacturer recommendations

Catchment devices measure to 0.01 inches

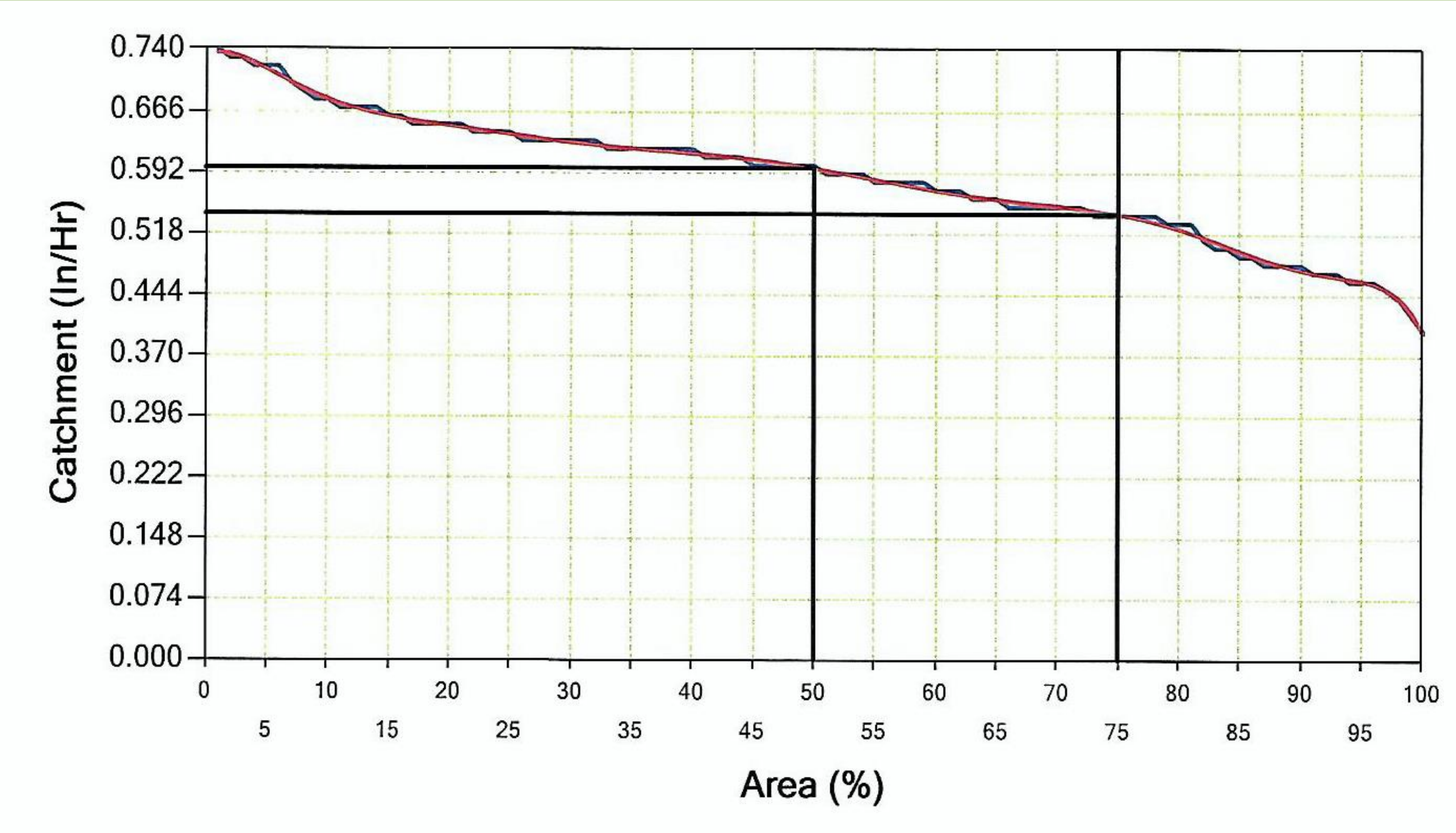
Testing

- Consider:
  - Operating pressure
  - DU_{lq}
  - Overspray
  - Percolation (excess)
  - Median and Effective application rate
  - Sprinkler Operating Efficiency

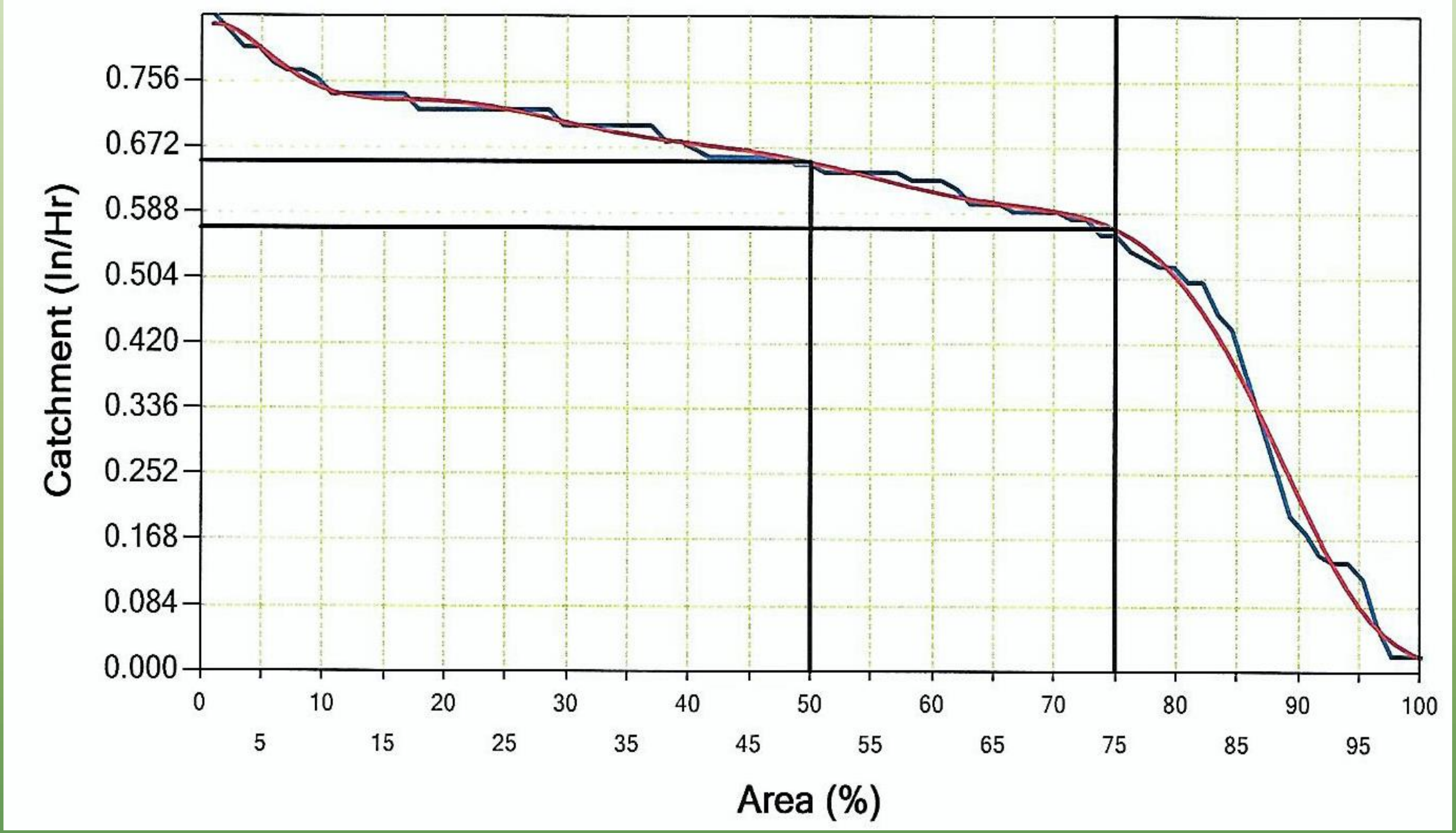
DU_{lq}=.40 OS=0.1% PL=42.7% OE_S= 57.2%



DU_{lq}=.83   OS=1.5%   PL=10.4% OE_S= 88.3%



DU_{lq}=.49 OS=6.8% PL=15.3% OE_S= 78.9%



Results-Spray

Nozzle	Shape	psi	PR_{median}	PR_{effect}	OS %	PL %	OE_S%	DU_{lq}
S	■	20	0.82	0.63	3.6	26.9	70.5	.62
S	■	30	0.94	0.79	3.8	18.7	78.2	.71
S	■	45	1.31	1.02	2.1	22.4	76.0	.60
S	●	20	0.85	0.63	8.6	30.4	63.6	.64
S	●	30	1.03	0.76	8.4	27.4	66.5	.68
S	●	45	1.24	0.98	8.6	23.5	69.9	.71

Same nozzle and spacing, different operating pressures

Results-MSMT

Nozzle	Shape	psi	PR_{median}	PR_{effect}	OS %	PL %	OE_S%	DU_{lq}
R-1	■	40	0.46	0.39	1.1	19.1	80.0	.66
R-2	■	40	0.60	0.54	1.5	10.4	88.3	.83
R-3	■	45	1.04	0.70	0.1	57.4	42.5	.40
R-1	●	40	0.48	0.37	1.8	27.0	71.7	.51
R-2	●	40	0.65	0.57	6.8	15.3	78.9	.49
R-3	●	45	1.35	0.88	6.0	36.6	59.6	.53

Rotating multi-stream, multi-trajectory nozzles

In 2014 CIT was asked to develop a protocol useful in administering sprinkler rebate programs

- The protocol would be administered by third-party testing agencies to:
  - Pre-qualify turf sprinklers for rebate programs
  - Establish current "state-of-the-art"
  - Provide incentives for ongoing improvements
  - ***Unfortunately no test protocol existed that calculated sprinkler application efficiency***

Current sprinkler test method:

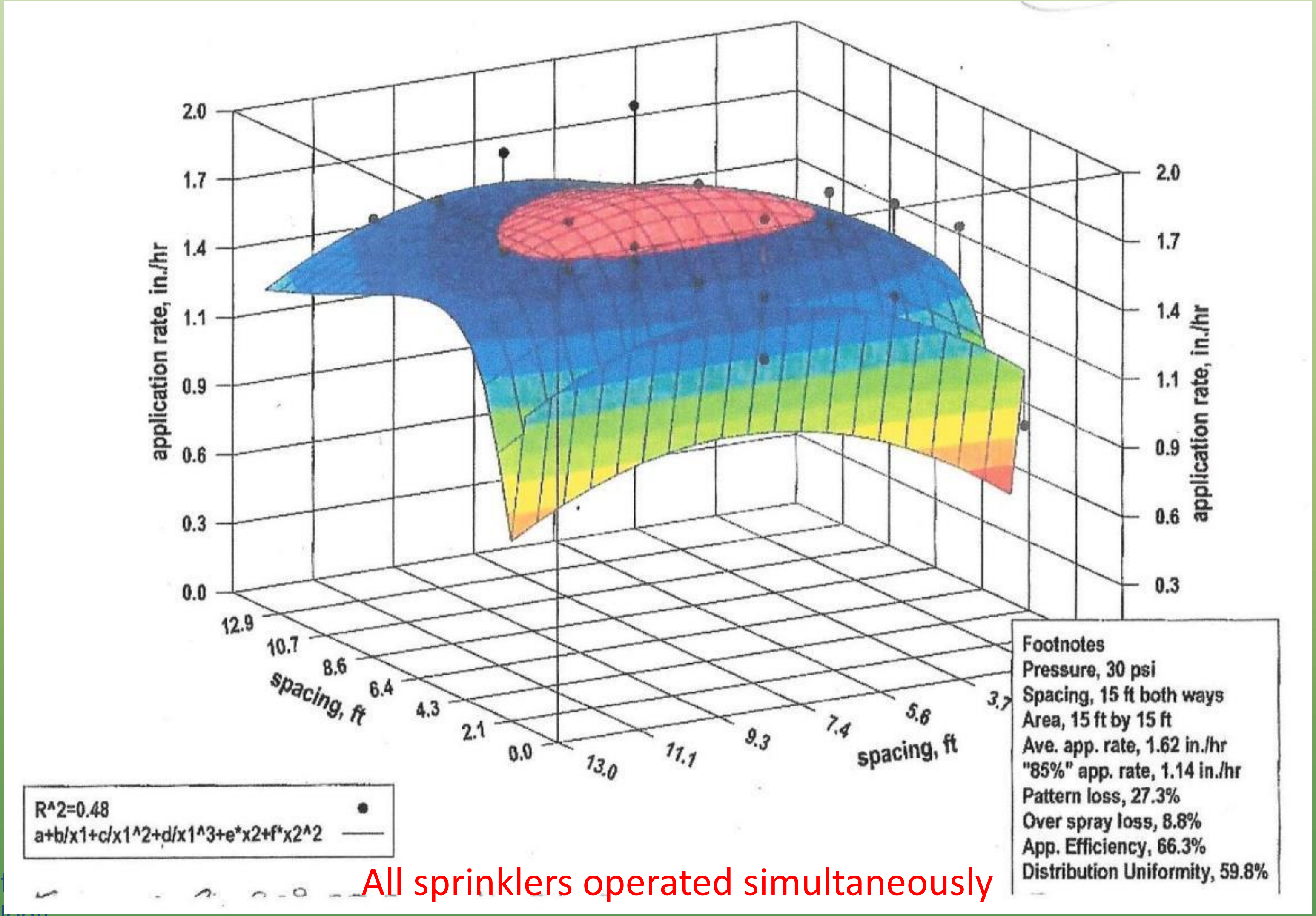
- NOT consistent with operational conditions
- Single head tested
- Computer simulation using multiple heads
- Makes no allowances for jet mechanical interference

Full scale irrigation set-up in CIT sprinkler test laboratory to evaluate performance

- Sprinkler heads operated simultaneously
- Sprinkler heads operated individually
- Application efficiency calculated for each

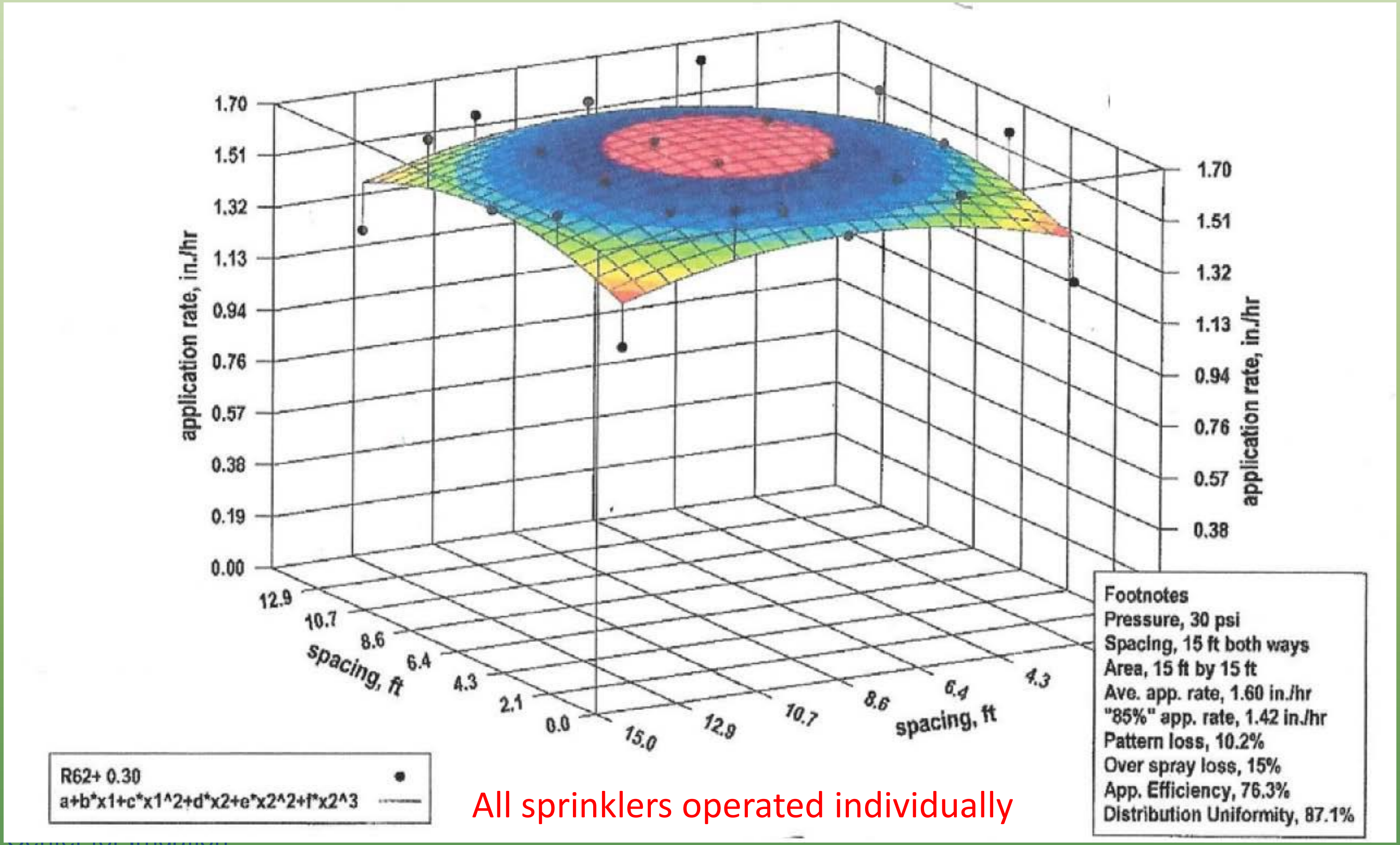
Irrigation Design/Operation Test Setup

Phenomena of Jet Interference = DU: 59.8



All sprinklers operated simultaneously

Non Interference = DU: 87.1



All sprinklers operated individually

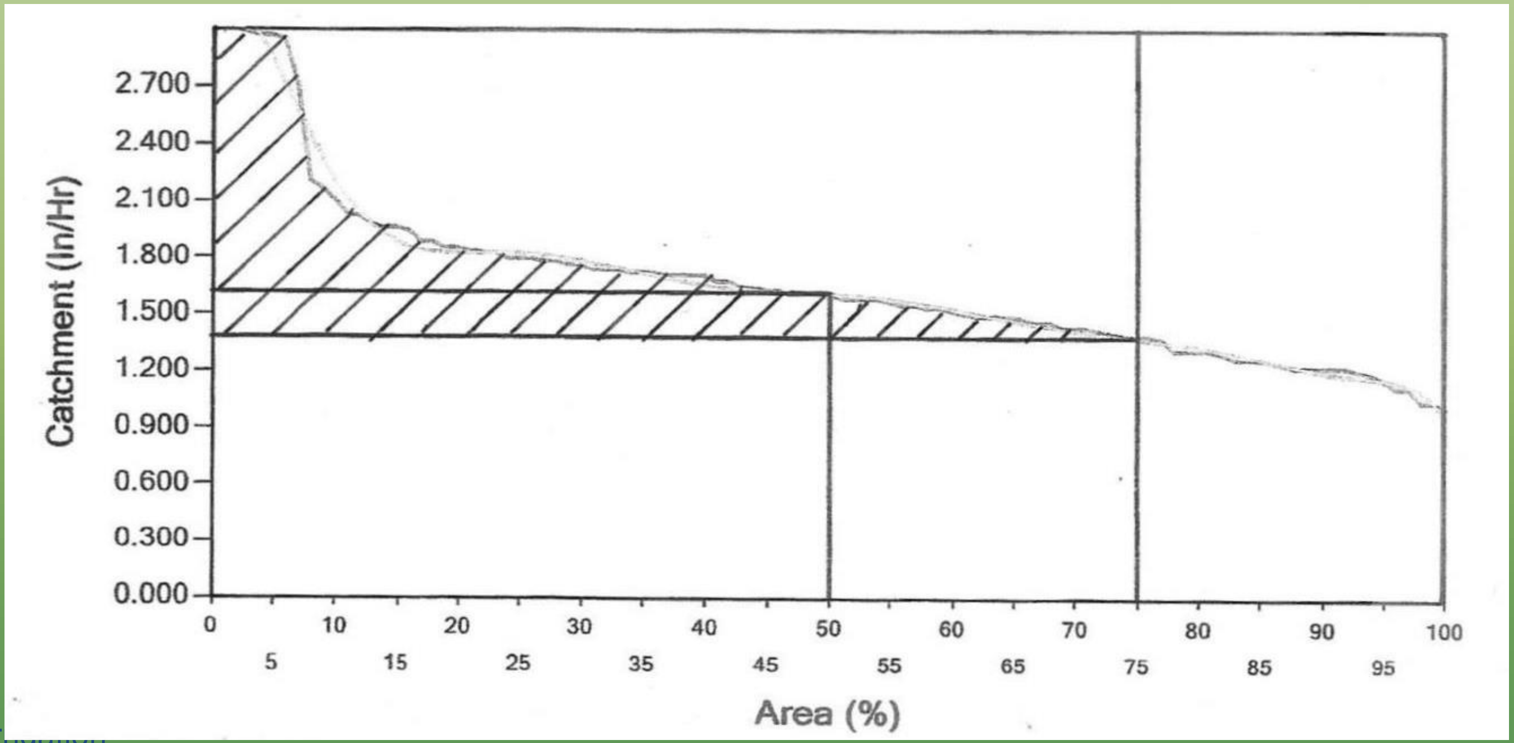
Center for Irrigation Technology

Test

- Tests conducted by CIT
- Defined shape and spacing
- Manufacturers supply the nozzle best suited to the situation.

$$Pattern\ Loss = \frac{\sum_1^{75}(x - x_i)}{100\ (\bar{x})}$$

Where x_i = app rate at 75% of area
$\bar{x}$ = average application rate



Results—Square

Nozzle	Shape	psi	PR_{median}	PR_{effect}	OS %	PL %	OE_S%	DU_{lq}
#1	■	30	1.62	1.38	1.0	20.1	79.1	.74
#2	■	30	1.61	1.40	0.1	19.3	80.6	.74
#3	■	40	0.61	0.56	6.2	12.7	81.9	.79
#4	■	30	1.63	1.28	2.0	25.4	73.1	.63
#5	■	30	1.25	1.09	0.9	21.2	78.1	.65
Avg					**2.0**	**19.7**	**78.6**	**.71**

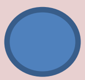
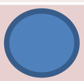
Manufacturers recommended and supplied the nozzle to irrigate a square shape that is 30 ft. x 30 ft. in size.

Results—Circular

Nozzle	Shape	psi	PR_{median}	PR_{effect}	OS %	PL %	S_{OE} %	DU_{lq}
#1		30	1.75	1.47	7.0	24.2	70.5	.63
#2		30	1.86	1.40	0.2	33.6	66.3	.29
#3		40	0.64	0.49	6.0	27.6	67.9	.41
#4		30	0.90	0.73	1.1	30.8	68.4	.55
#5		30	1.82	1.45	10.0	23.6	68.7	64
Avg			**0.65**	**0.57**	**4.9**	**28.0**	**68.4**	**.50**

Manufacturers recommended and supplied the nozzle to irrigate a circular shape that is 30 feet in diameter.

Comparison—same nozzle

Nozzle	Shape	psi	PR_{median}	PR_{effect}	OS %	PL %	S_{OE} %	DU_{lq}
#1-a		30	1.62	1.38	1.0	20.1	79.1	.74
#1-b		30	1.75	1.47	7.0	24.2	70.5	.63
#1-c		30	1.86	1.40	0.2	33.6	66.3	.29

Same nozzle. Test #1-c is “fine-tuning” after test #1-b

Study at Cal Poly-Pomona

- Distribution Uniformity of Multi-Stream, Multi-Trajectory Rotary Nozzles Spaced Below Recommended Distance
  - Kumar, Green, Vis

Study: RMSMT nozzles

- Maximum spacing HTH
- Spacing reduced 10%, nozzle unadjusted
- Spacing reduced 25%, nozzle unadjusted
- Spacing reduced 10%, nozzle adjusted
- Spacing reduced 25%, nozzle adjusted

10% = common design practice

25% = common maximum radius adjust

Study Results--DU_{lq}

Treatment	Nozzle A	Nozzle B	Nozzle C	Overall
Max HTH	.58	.58	.45	.54
-10% unadj.	.64	.65	.57	.62
-25% unadj.	.59	.78	.62	.66
-10% adjust.	.81	.76	.52	.70
-25% adjust.	.75	.74	.67	.72
Overall	.68	.71	.56	.65

Average of four replications

Unadjusted = over spraying target area

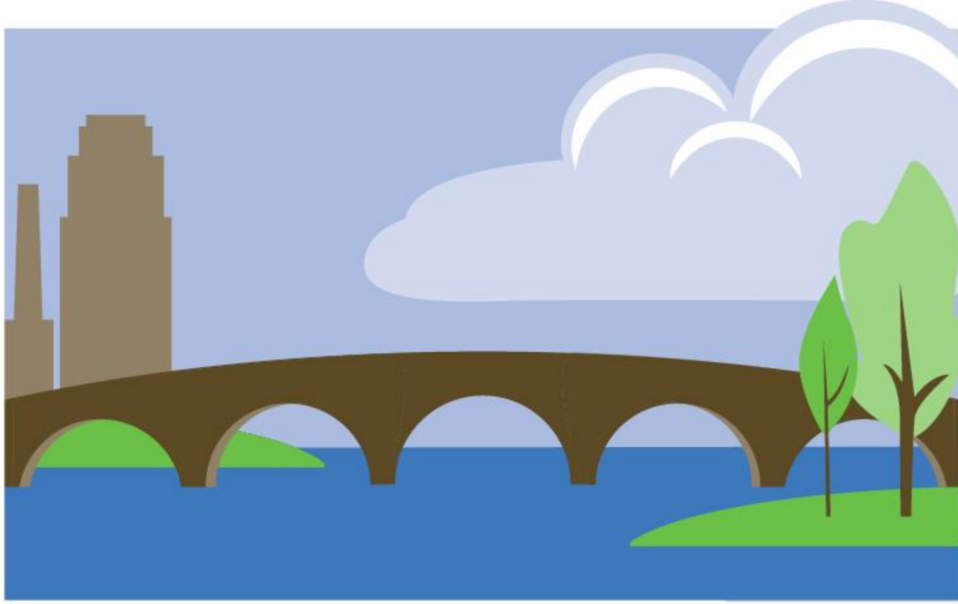

Questions ?
Thank You !

Conclusions

- Curvilinear shapes are more difficult to irrigate efficiently.
- DU is one metric—focus is on “dry”
- Sprinkler operation efficiency considers where is the water going.
- MSMT nozzles create less interference of pattern.
- Keeping water on target is more important than highest DU.

Recommendations

- Reduce catalog info by 10-15%
- Adjust nozzle to keep water on target
- Shoot for highest DU possible
- Use the real application rate for scheduling
- Limit extra run time to no more than 20%
- If there are persistent dry areas—fix the sprinklers, or check for other causes
- Install sprinklers expertly
  - Spacing, correct nozzle, aligned, plumb, etc.



CONNECTING THE BUILT AND NATURAL ENVIRONMENT

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Creating Efficiency in Design Using Hydraulic Modeling

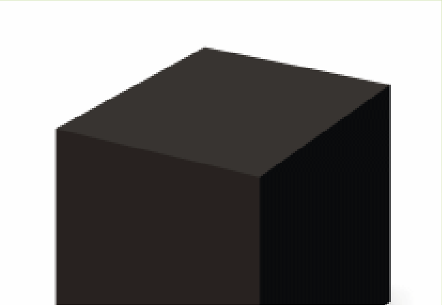
Joel Johnson, Bentley Systems, Inc.

ASIC

Presentation Overview

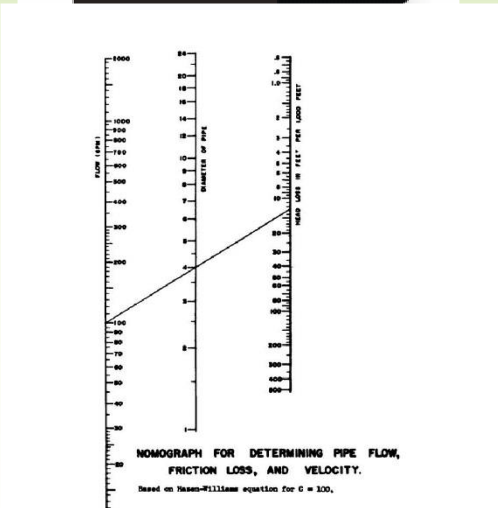
- Introduction
- Basics of Hydraulics
- Available Modeling Tools
- Workshop
  - Construction of a Hydraulic Model
  - How to Use Model Results

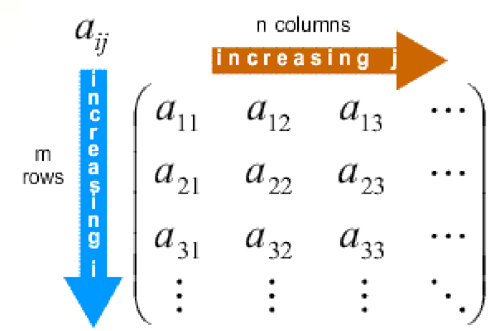
Hydraulic Modeling Survey



What is the “black box” behind a hydraulic model?

- One of those nomograph chart things that you draw lines on to size pipes
- A series of spreadsheet calculations using engineering formulas
- A complex algorithm that simultaneously solves for the water pressure and flow in a pipe network





Survey (continued)

The last time I used hydraulic modeling was:

- Um… Never?
- I remember a course back in college…
- We had a big project once, so we used hydraulic modeling software
- I use it on most, if not all, pressure system designs

CONNECTING THE BUILT AND NATURAL ENVIRONMENT

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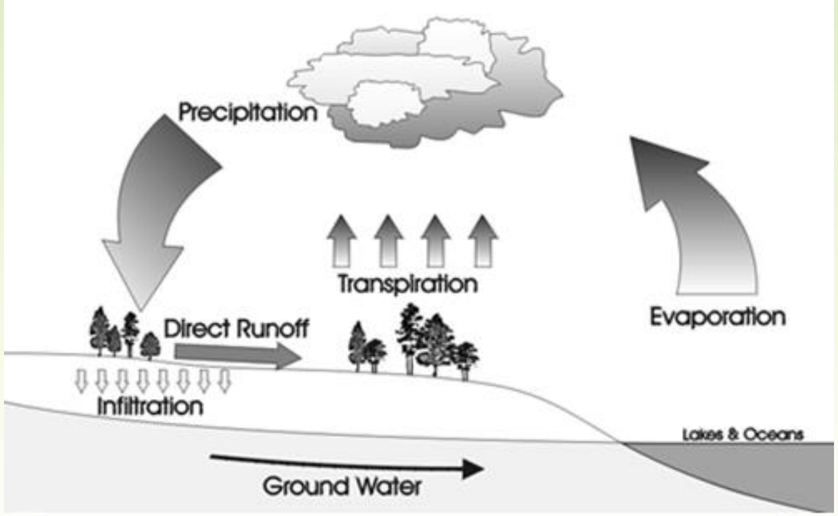
Hydologic vs. Hydraulic Modeling
Basics of Hydraulics

Types of Modeling

<u>Hydrologic Modeling:</u>

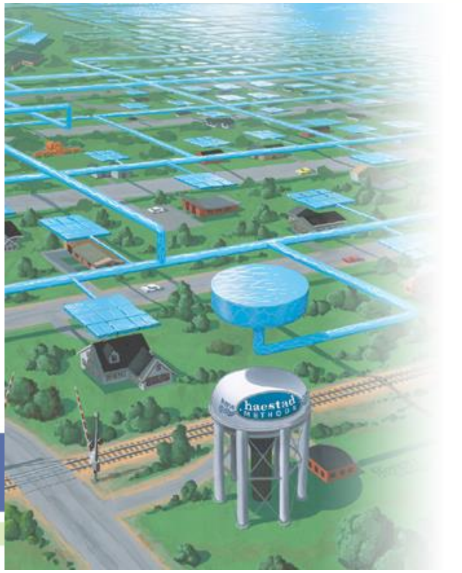
Rainfall, Runoff



<u>Hydraulic Modeling:</u>

Pipes, Channels,

Engineered Systems



Types of Modeling

CONNECTING THE BUILT AND NATURAL ENVIRONMENT

Gravity Flow Systems: Ditches, Channels, and Pipes that are not flowing at full depth

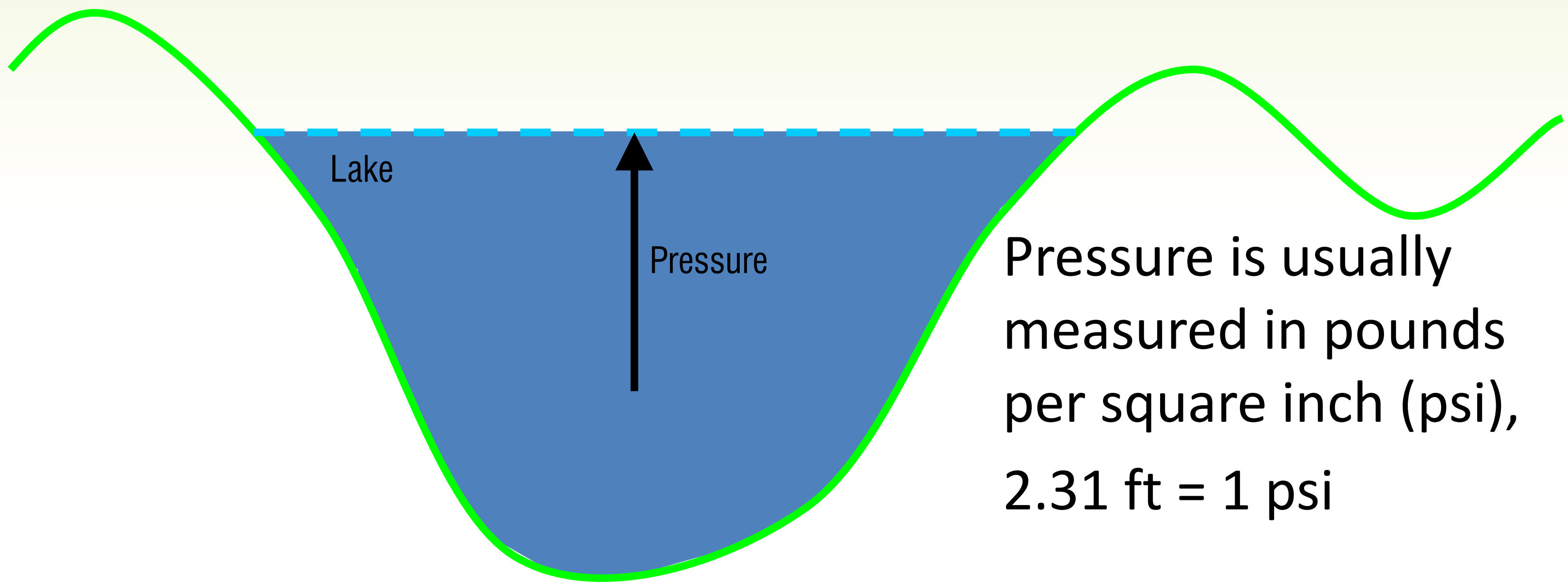
stormwater conveyance, gravity sewers

Pressurized Flow Systems: Pipes are flowing full, interaction with pumps, storage, and discharge under pressure

water distribution, fire protection, sprinklers

Pressure System Hydraulics

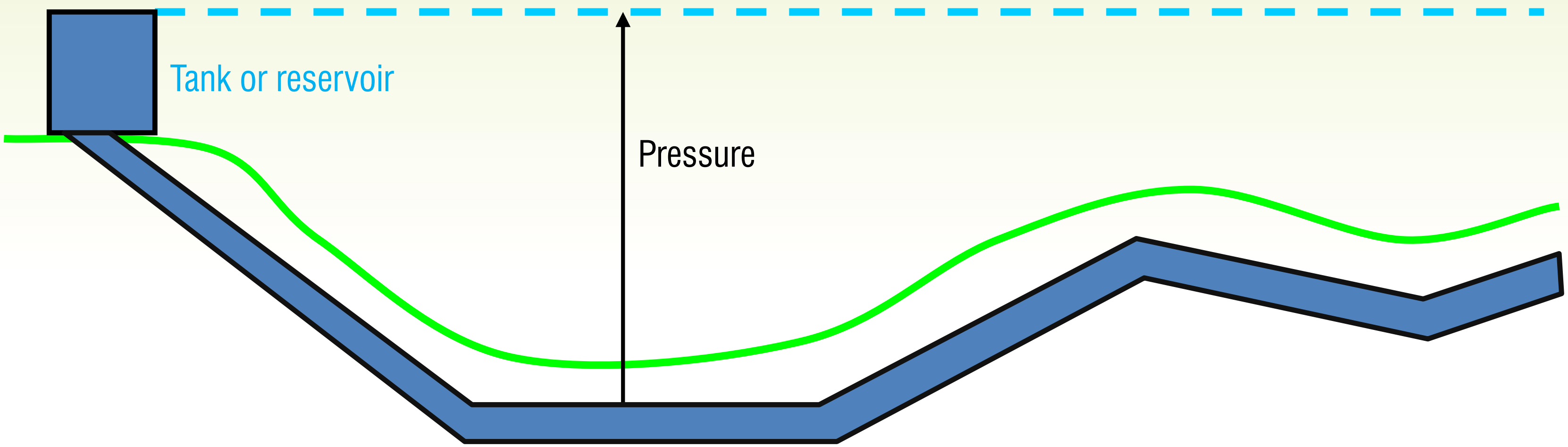
- Pressure measured at any point in a volume of water is caused by the weight of the liquid above that point



Pressure is usually measured in pounds per square inch (psi), 2.31 ft = 1 psi

Hydraulics in a Pipe

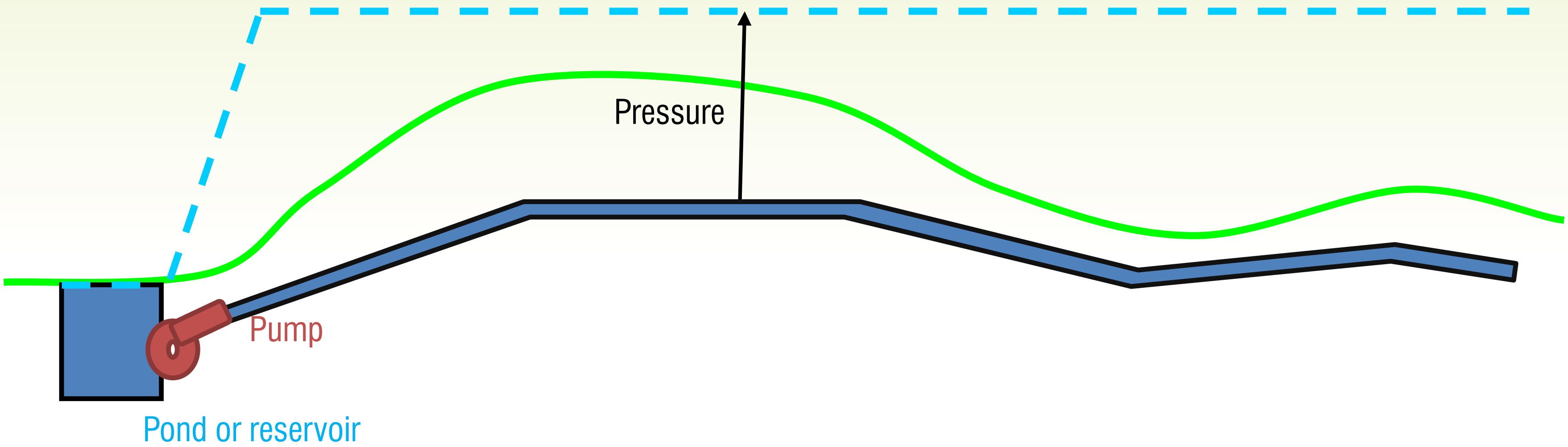
- In a pressure system the water is enclosed within pipes



- The water surface is now in the tank therefore the pressure is measured vertically to this point

Pumped Systems

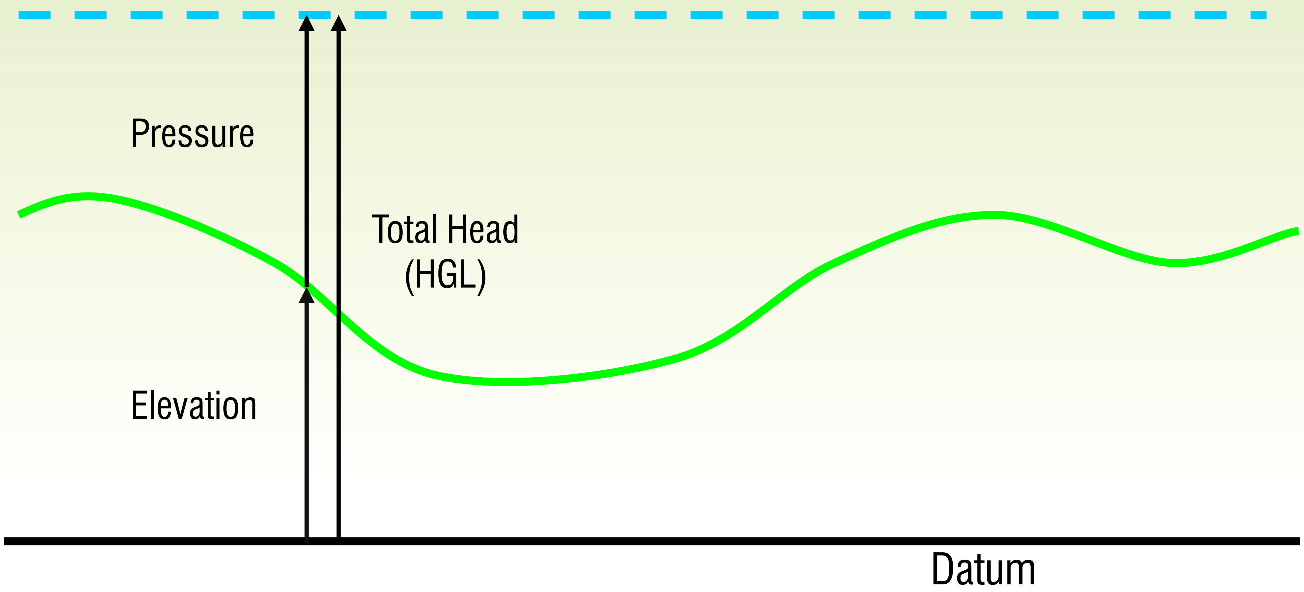
- If the stored water is lower than the delivery point, you must design a pump to achieve the desired pressure



- Design pressure of 60 psi ~ 150 feet: pump must add this in addition to any elevation change (total head)

Hydraulic Grade Line (HGL)

- What is total head (HGL) ?



- It is the pressure you would measure if you were at sea level
- Therefore total head or HGL = Elevation + Pressure

Hydraulic Model Computations

- Hydraulic models work in total head (HGL)
- Pressures are defined by subtracting the elevation from the total head (HGL):

  Pressure = HGL – Elevation

- It takes energy to transport water along a pipeline

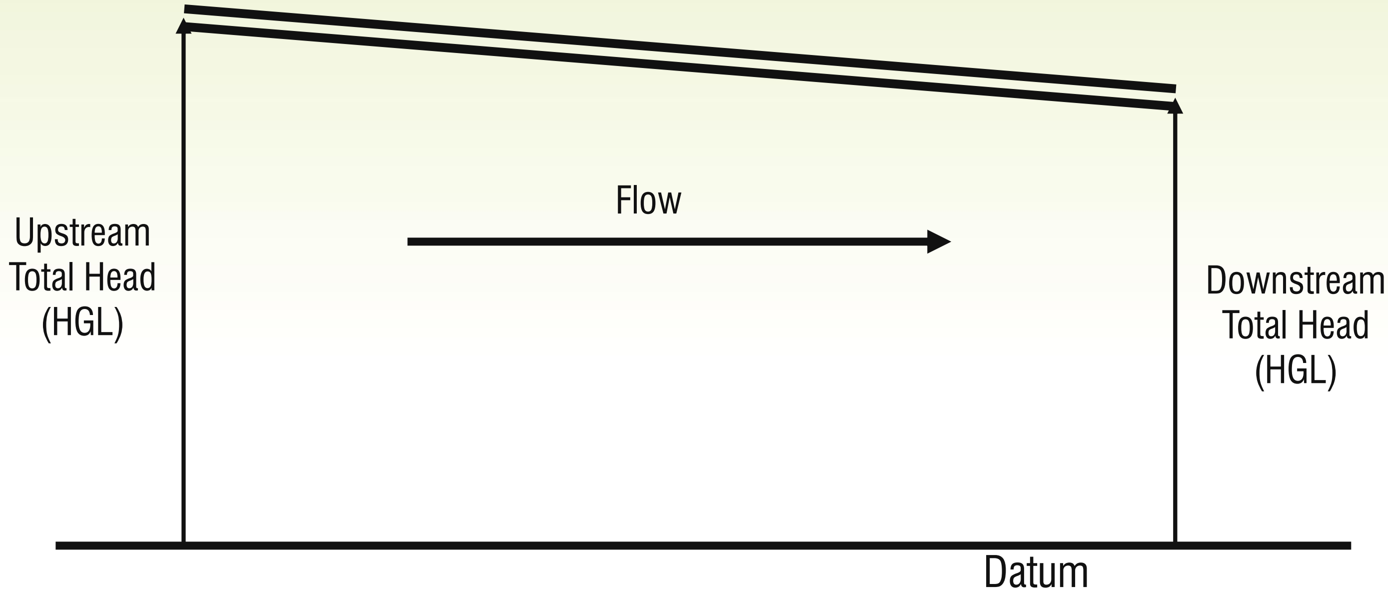
  This energy is taken from the water's potential energy (HGL)

- So as you travel away from the water source the HGL reduces
  - This reduction/loss of HGL is known as **HEAD LOSS**

Head Loss

CONNECTING THE BUILT AND NATURAL ENVIRONMENT

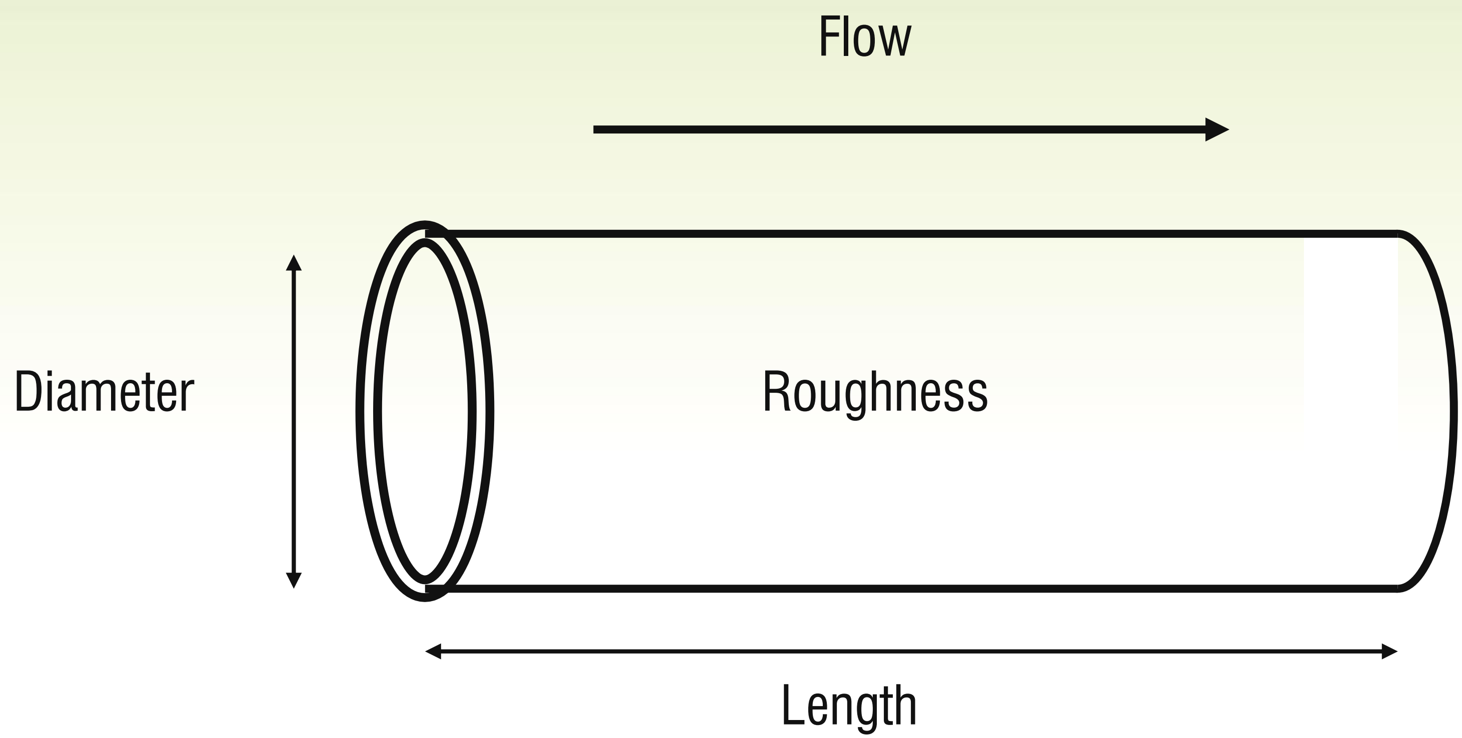
- HEAD LOSS is calculated as the difference in the HGL from one end of a pipe to the other



- HEAD LOSS = Upstream HGL – Downstream HGL

Head Loss in Piping Systems

- What causes Head Loss in a pipe?



Hydraulics

- What is the relationship of Length, Roughness, Flow and Diameter to Head Loss?

Hazen Williams: $h = \frac{KL}{D^{4.87}}\left(\frac{Q}{C}\right)^{1.85}$ Darcy Weisbach: $h = \frac{KLfQ^2}{D^5}$

  - Headloss ∝ Length
  - Headloss ∝ f(Roughness)
  - Headloss ∝ Flow^2
  - Headloss ∝ 1 / Diameter^5

- Therefore, changing **Diameter** has the greatest impact on Head Loss

Other Losses

- What else in the piping system can cause Head Loss?

  - Meters, sensors, or other measurement devices
  - Valves
  - Backflow preventers
  - Filters
  - Reducers
  - Bends and fittings

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Modeling Software and Process

Why Model?

Hydraulic modeling can help:

- Determine the expected pressure distribution in a system
- Evaluate storage capacity/needs and volume supplied
- Evaluate parallel/concurrent operation of systems
- Determine appropriate pipe size
- Evaluate operation schedules and determine constraints
- Evaluate pumping needs and efficiency

What Tools Are Available?

Public Domain Software

- EPANET (http://www.epa.gov/nrmrl/wswrd/dw/epanet.html)
  - Advantages: Free! Widely used, minimal footprint on computer, relatively easy to use, access to source code
  - Disadvantages: No support, no upgrades, limited interface, no interaction with mapping or CAD software

Commercially Available Software

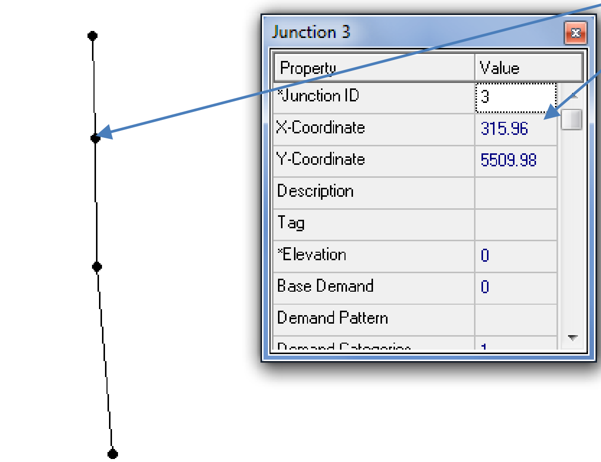
- Advantages: technical support, continued upgrade and development, advanced analytical features, can integrate with GIS and/or CAD platforms
- Disadvantages: Cost (compared to EPANET), multiple vendors

"Workshop"

- Use GIS base map to set up simple golf course model
- System Components:
  - Water source / storage (pond at constant level)
  - Pump station (1 pump)
  - Pipes (2" to 6")
  - Sprinkler heads
- Design flow rate – use rotor sprinkler head with 60' coverage radius, 30 gpm flow rate

Model Construction

- In EPANET, place junctions at sprinkler locations
- May be helpful to have CAD alongside, use northing and easting and input manually
- CAD or GIS embedded can overlap on basemap and place using strategic symbol size



EPANET: Place junctions and edit coordinates

Get coordinates from GIS or CAD or use background file in embedded modeling platform

System Layout

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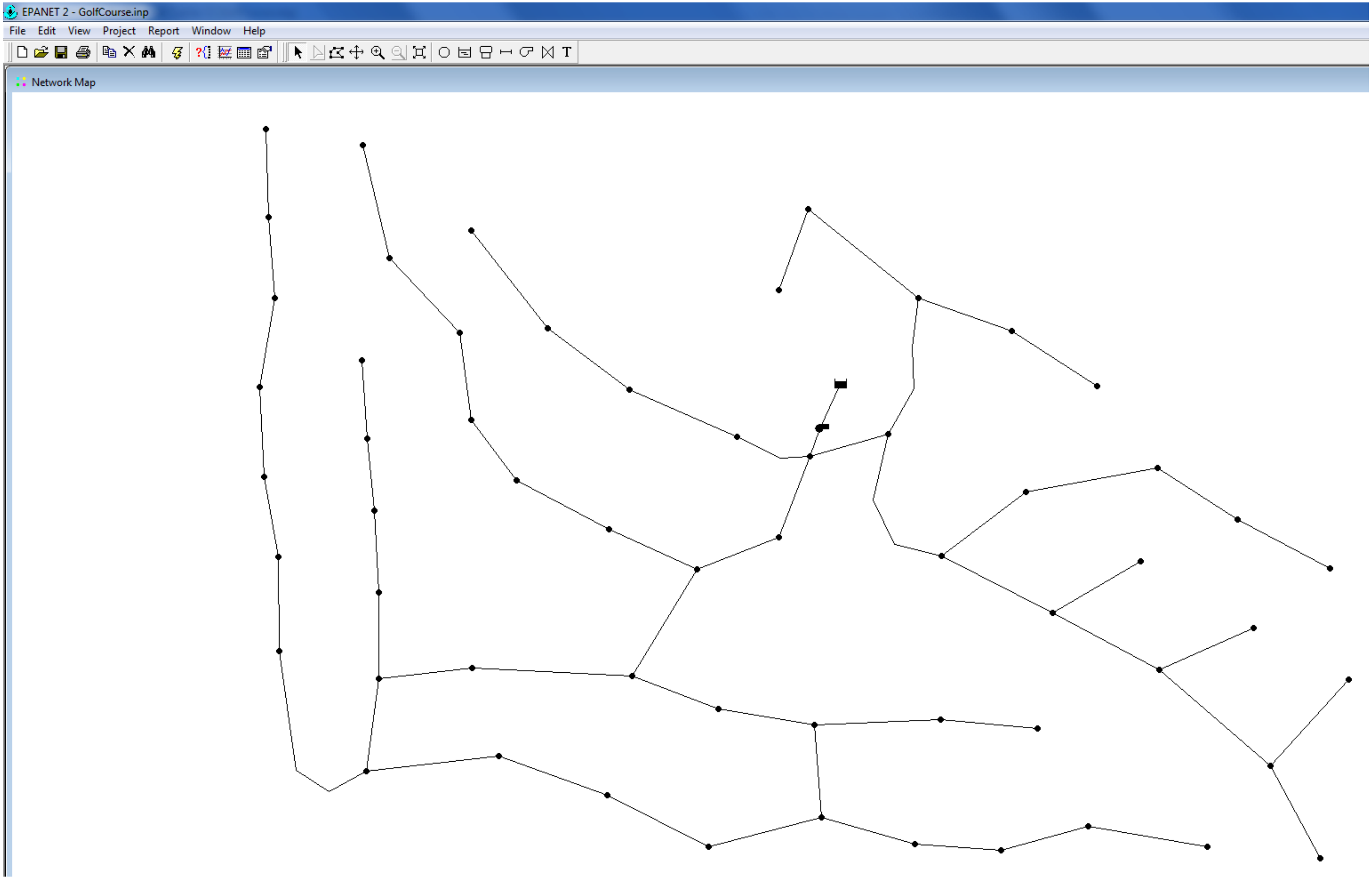
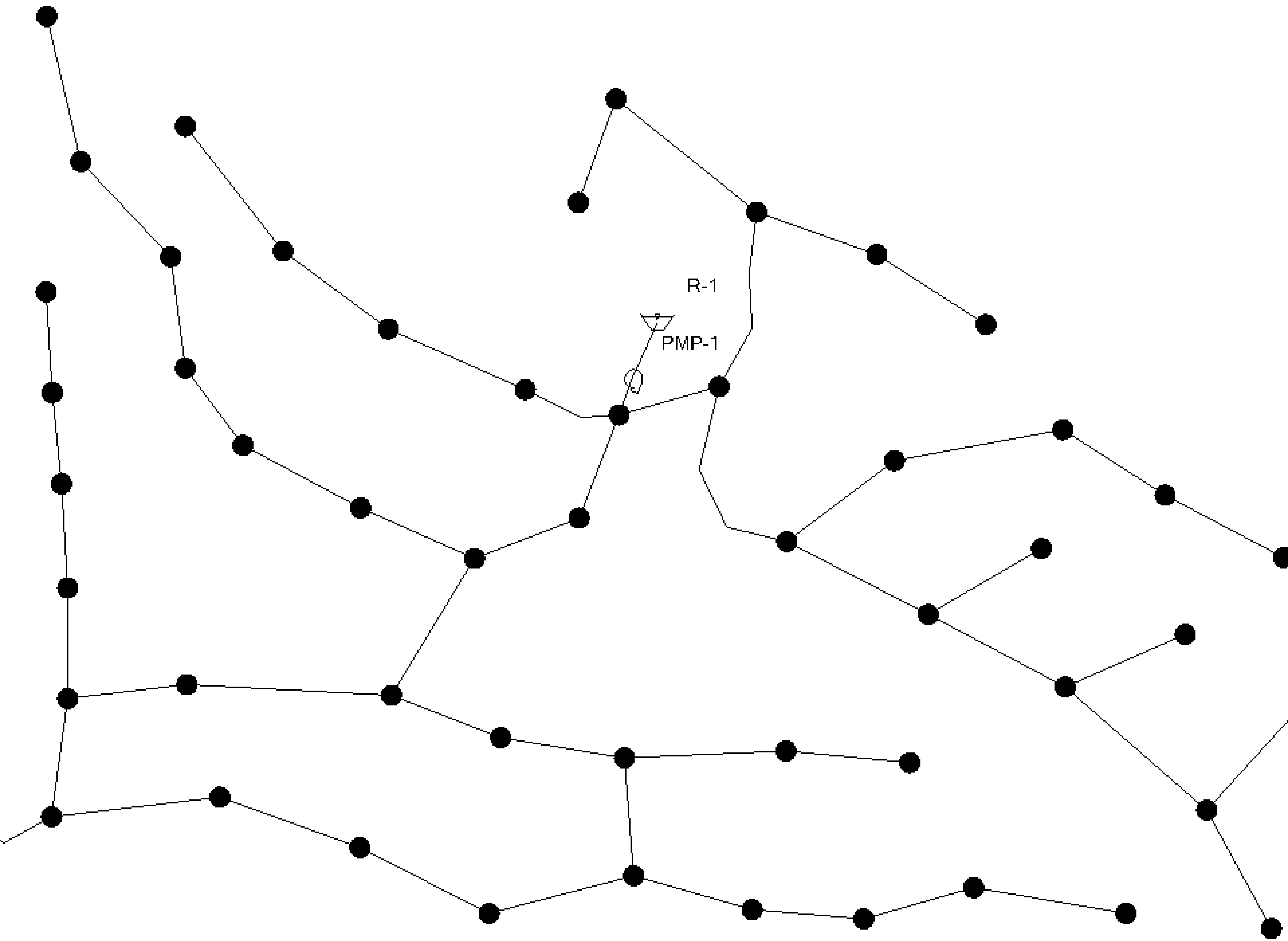
- "Connect the Dots" – create pipes by literally connecting sprinklers.
- Use uniform size at first, can adjust later based on analysis results
- Establish source and pump as necessary


EPANET 2 - GolfCourse.inp
File Edit View Project Report Window Help
Network Map


R-1
PMP-1

Elevation Data

- Utilize ground surface data
  - Generally available through State/University sites
- Commercial programs have extraction utilities to extract elevations at nodes
- Include elevation and relevant volume of any storage features – these can be set as constant head or as varying level (requires level/storage capacity relationship)

Initial Settings

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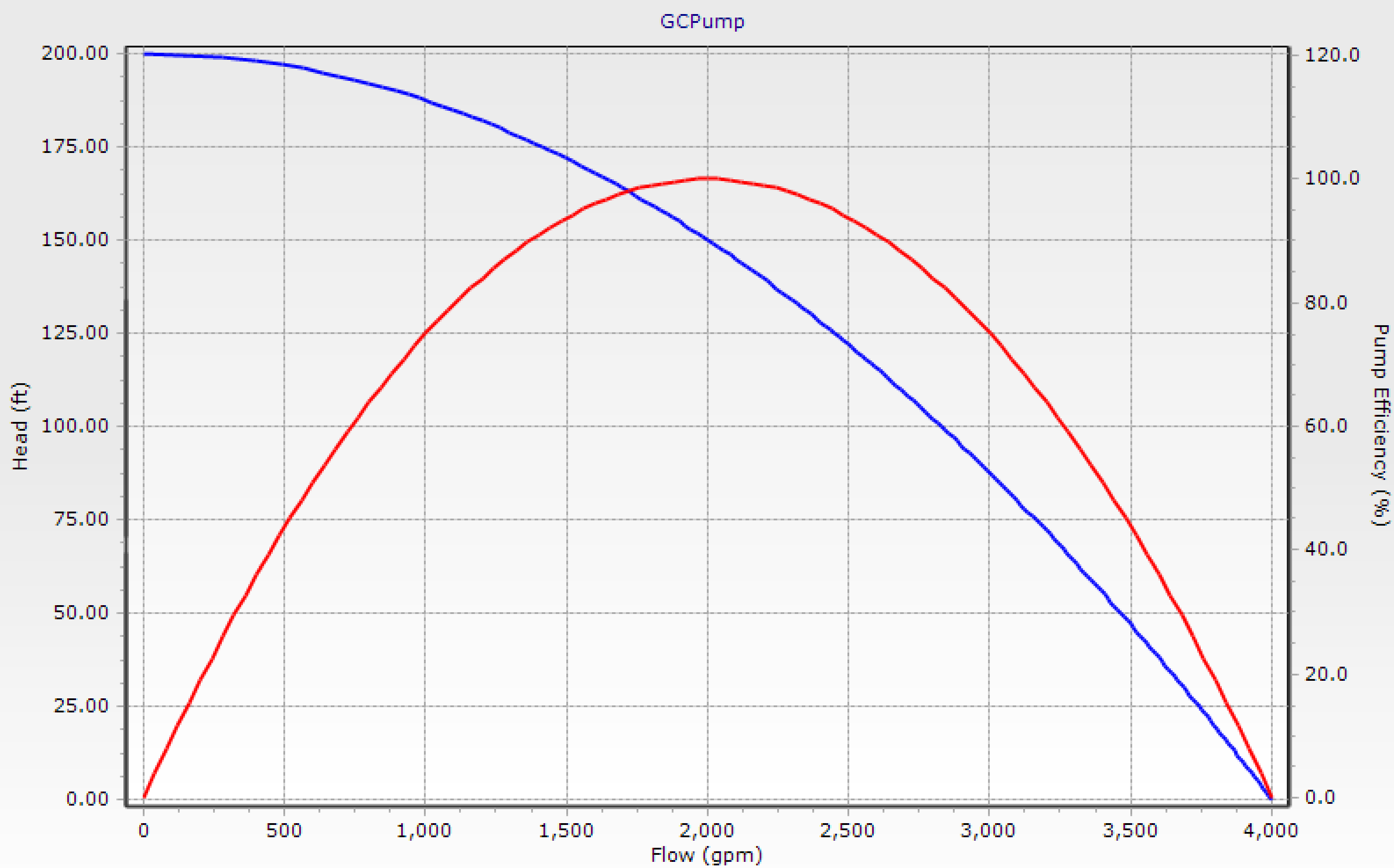
- Use one-point pump definition, unrealistically large for pipe sizing
  - Design Flow @ maximum with all sprinklers running
  - Head @ 60-80 psi on discharge side
- “Demands” = sprinkler output
  - Initially set all sprinklers on
- Pipe size:
  - Start with network at one size
  - Work from source to extremes, increase pipe size when head loss is extreme

Pump Definition Type: Design Point (1 Point)

	Flow (gpm)	Head (ft)
Shutoff:	0	200.00
Design:	2,000	150.00
Max. Operating:	4,000	0.00



Pipe Size Adjustment

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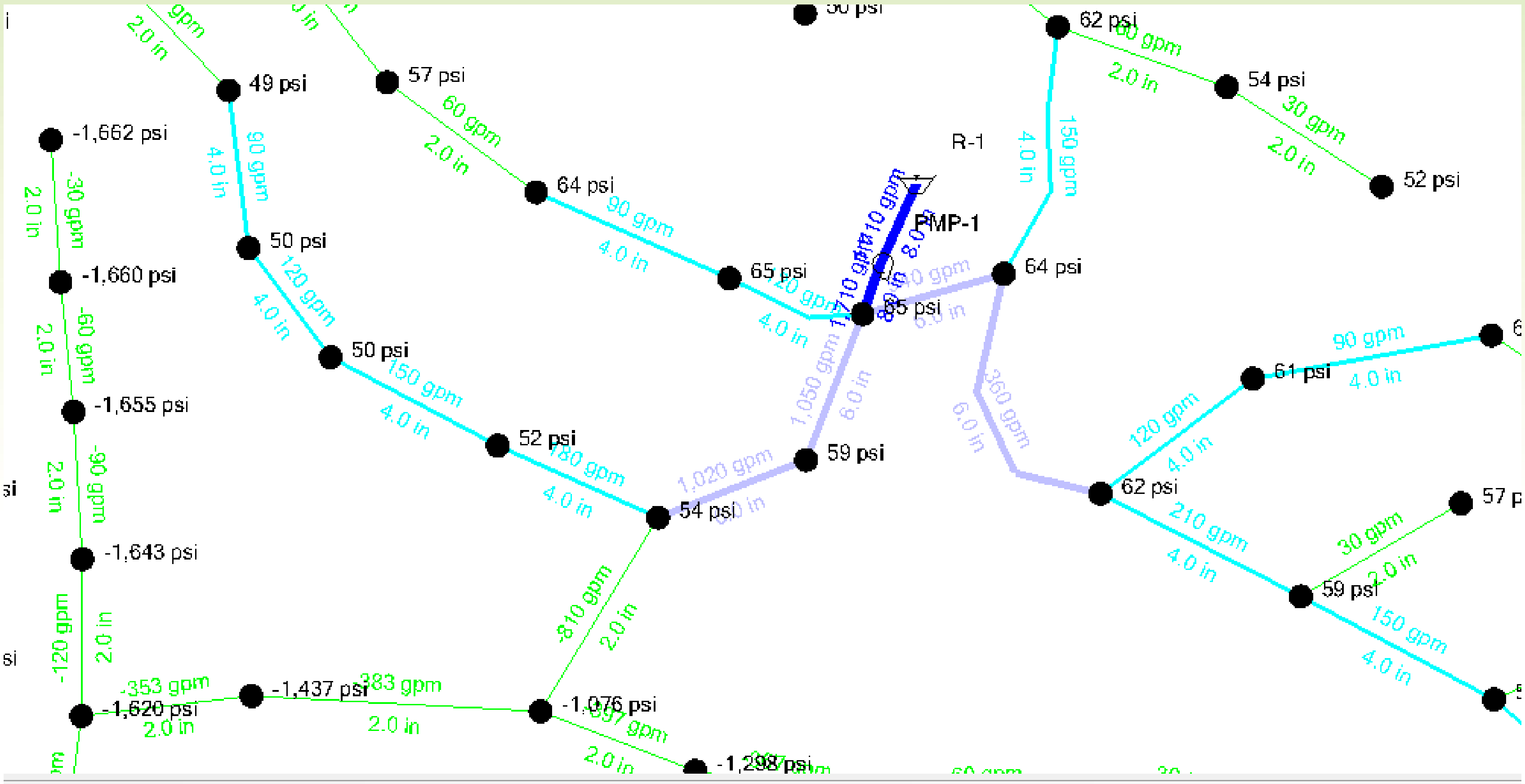

Final Adjustments

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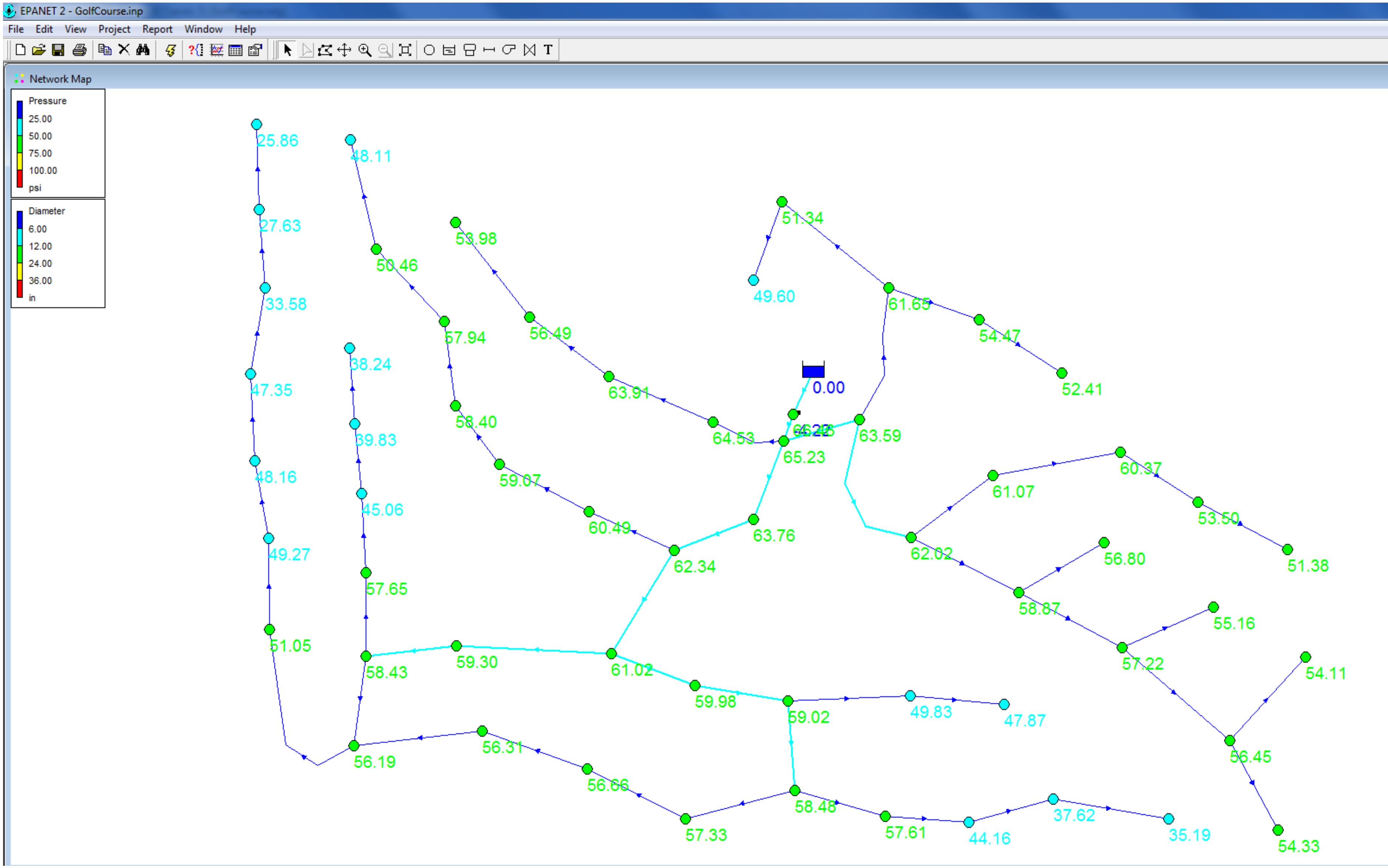
- Add other "loss" items
  - Valves (define minor loss coefficient)
  - Filters
  - Backflow prevention
  - Bends/fittings
  - Etc.
- Readjust pipe or pump size if not meeting pressure at extremes


EPANET 2 - GolfCourse.inp
File Edit View Project Report Window Help
Network Map
Pressure
25.00
50.00
75.00
100.00
psi
Diameter
6.00
12.00
24.00
36.00
in
25.86
48.11
27.63
50.46
53.98
51.34
33.58
49.60
61.65
57.94
56.49
54.47
38.24
52.41
47.35
0.00
63.91
58.40
39.83
64.53
63.59
65.23
48.16
59.07
60.37
61.07
45.06
53.50
60.49
63.76
62.02
51.38
49.27
62.34
56.80
57.65
58.87
55.16
51.05
59.30
58.43
61.02
57.22
54.11
59.98
59.02
49.83
47.87
56.19
56.31
56.45
56.66
58.48
37.62
57.61
35.19
57.33
44.16
54.33

Make it Real

- Activate sprinklers in realistic operation and eliminate “demands” for sprinklers that are off
  - Valve closure shouldn’t matter – modeling at steady state so if there is no flow, there is no head loss
- Size the pumps based on realistic flow vs. head
- Replace one-point pump curve with defined pump curve from vendor literature

What Else Can I Do?

- Use “Extended period simulation” (EPS) modeling to define daily watering pattern
  - Cumulative flow to define volume of water applied
  - Iteratively check how you can or can’t concurrently run areas of the system
  - Evaluate use from storage, necessary daily water purchase

What Else Can I Do?

CONNECTING THE BUILT AND NATURAL ENVIRONMENT

- Pressure Dependent Demands
  - Sprinklers flow at rate dependent upon system pressure
  - Render results with symbol sizes to show coverage

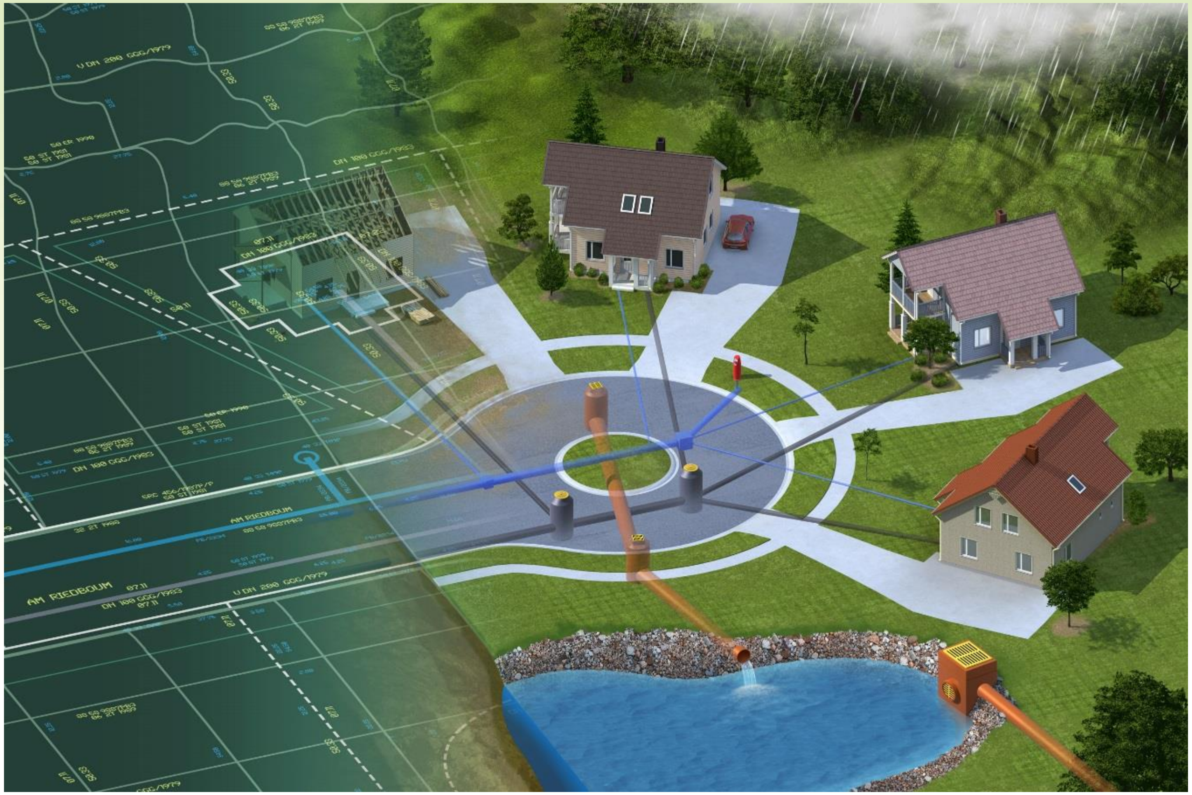
- Automated cost/benefit optimization of pipe sizes

In Summary

CONNECTING THE BUILT AND NATURAL ENVIRONMENT

- Hydraulic modeling can help:
  - Layout of system/coverage area
  - Size pipes
  - Design necessary pumping
  - Evaluate potential operational schemes
  - Show effects of operational schemes on storage/source water as well as effective coverage
  - Understand the flexibility and limitations of the designed system

THANK YOU!



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GATE VALVES

Slide 29

GATE VALVES

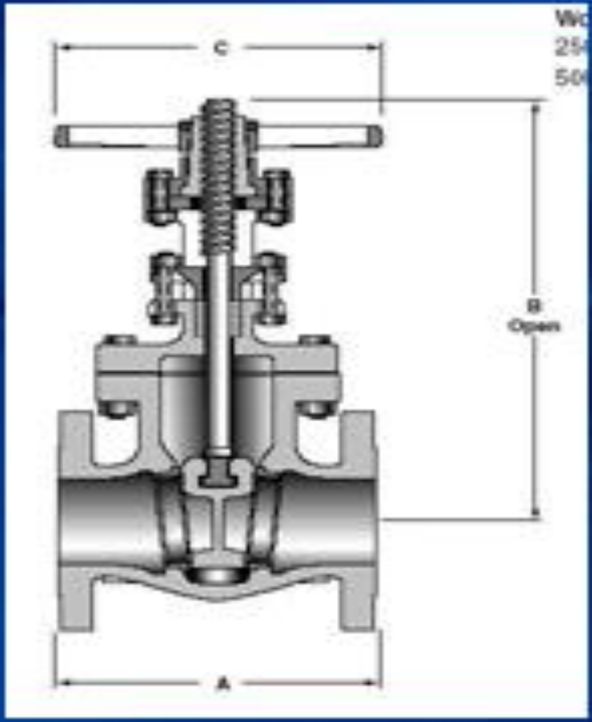
NRS Gate Valve

OS&Y Gate Valve

Knife Gate Valve

Slide 30

WEDGE TYPE GATE VALVES



Solid Wedge

Resiliant wedge

ASIC

AWWA Torque Requirements

Table 1 Design valve stem input torque

Nominal Valve Size or NPS		Design Torque	
in.	*(mm)*	*ft-lb*	*(Nm)*
3–4	(75–100)	200	(270)
6–16	(150–400)	300	(406)
Larger than 16	(400)	Consult manufacturer	