Building a Dynamic, Consent Decree-Approved Model from the Ground Up

NEWEA Collection Systems Specialty Seminar
September 10, 2014

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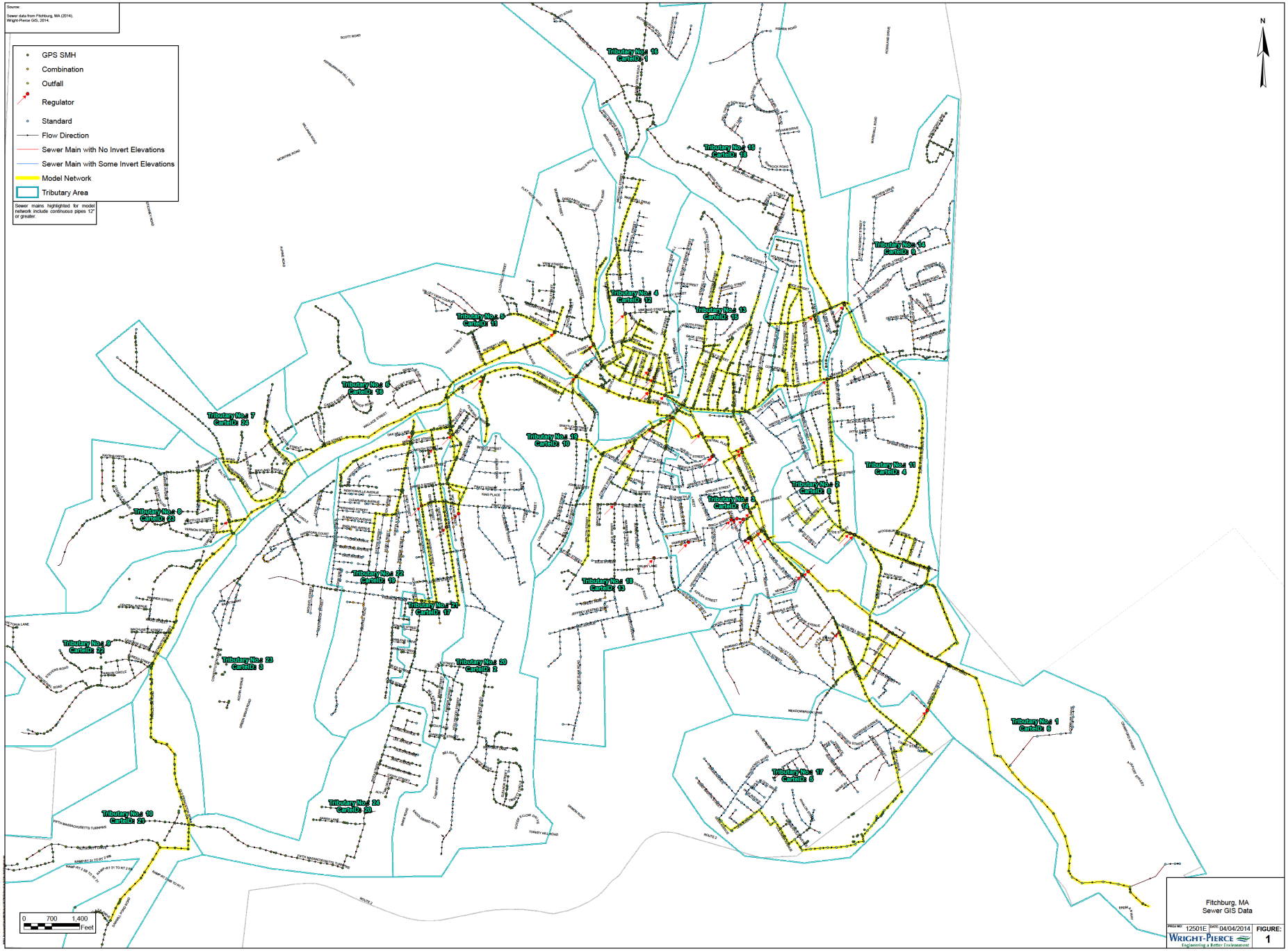
WRIGHT-PIERCE
Engineering a Better Environment

Overview

- Background and Goals
- Project Schedule
- Project Approach
- Next Steps
- Questions and Answers

Sewer System / Combined Sewer System

- Combined Sewer System
  - 220 miles of collection system
  - Majority of sewers are separated
  - WWTF – 9.8 MGD ADF
  - 30 +/- Combined Sewer Outfalls


Source:
Sewer data from Fitchburg, MA (2014).
Wright-Pierce GIS, 2014.
GPS SMH
Combination
Outfall
Regulator
Standard
Flow Direction
Sewer Main with No Invert Elevations
Sewer Main with Some Invert Elevations
Model Network
Tributary Area
Sewer mains highlighted for model network include continuous pipes 12" or greater.
N
Tributary No.: 16 CartoID: 1
Tributary No.: 15 CartoID: 11
Tributary No.: 14 CartoID: 9
Tributary No.: 4 CartoID: 12
Tributary No.: 13 CartoID: 18
Tributary No.: 6 CartoID: 14
Tributary No.: 5 CartoID: 16
Tributary No.: 7 CartoID: 24
Tributary No.: 12 CartoID: 10
Tributary No.: 11 CartoID: 4
Tributary No.: 2 CartoID: 6
Tributary No.: 3 CartoID: 15
Tributary No.: 8 CartoID: 20
Tributary No.: 22 CartoID: 19
Tributary No.: 18 CartoID: 13
Tributary No.: 21 CartoID: 17
Tributary No.: 9 CartoID: 22
Tributary No.: 23 CartoID: 3
Tributary No.: 20 CartoID: 2
Tributary No.: 1 CartoID: 0
Tributary No.: 17 CartoID: 5
Tributary No.: 24 CartoID: 23
Tributary No.: 10 CartoID: 21
0 700 1,400 Feet
Fitchburg, MA
Sewer GIS Data
PROJ NO: 12501C
DATE: 04/04/2014
FIGURE: 1
WRIGHT-PIERCE
Engineering a Better Environment

Goals

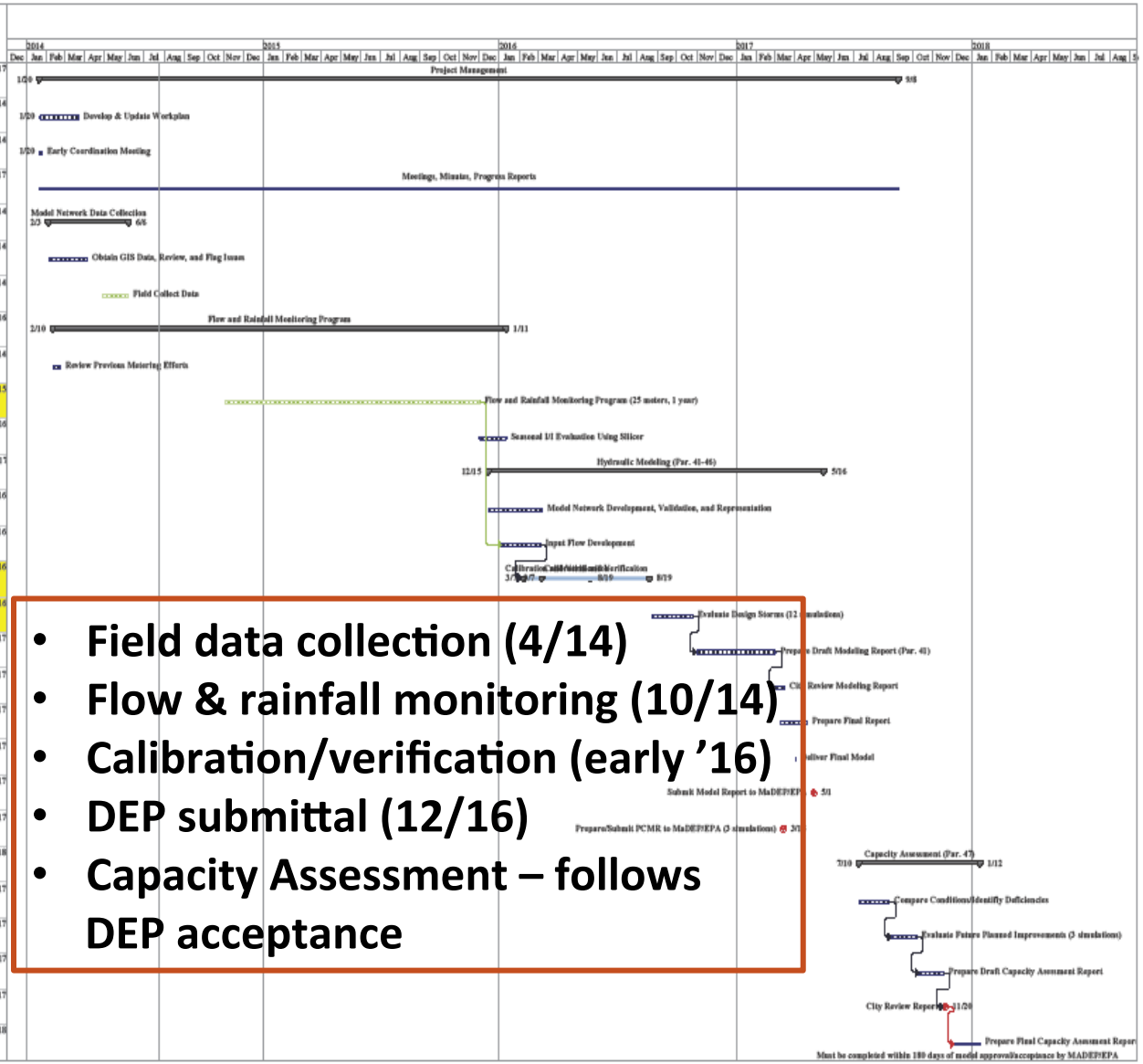
- Comply with Consent Decree requirements
  - Model Completion December 2016
- Better understand existing sewer system
- Provide recommendations on how to
  - Eliminate future SSOs and CSOs
  - Reduce I/I
  - Provide more hydraulic capacity
- Internal goals such as updated GIS data

Project Schedule

- Field Work – April 2014 to June 2014
- Flow Metering – Oct. 2014 to Oct. 2015
- Model Network Development
  - Select modeling software – September 2013
  - Modeling software training – July 2014
  - Build physical model – Aug. 2014 to Jan. 2015

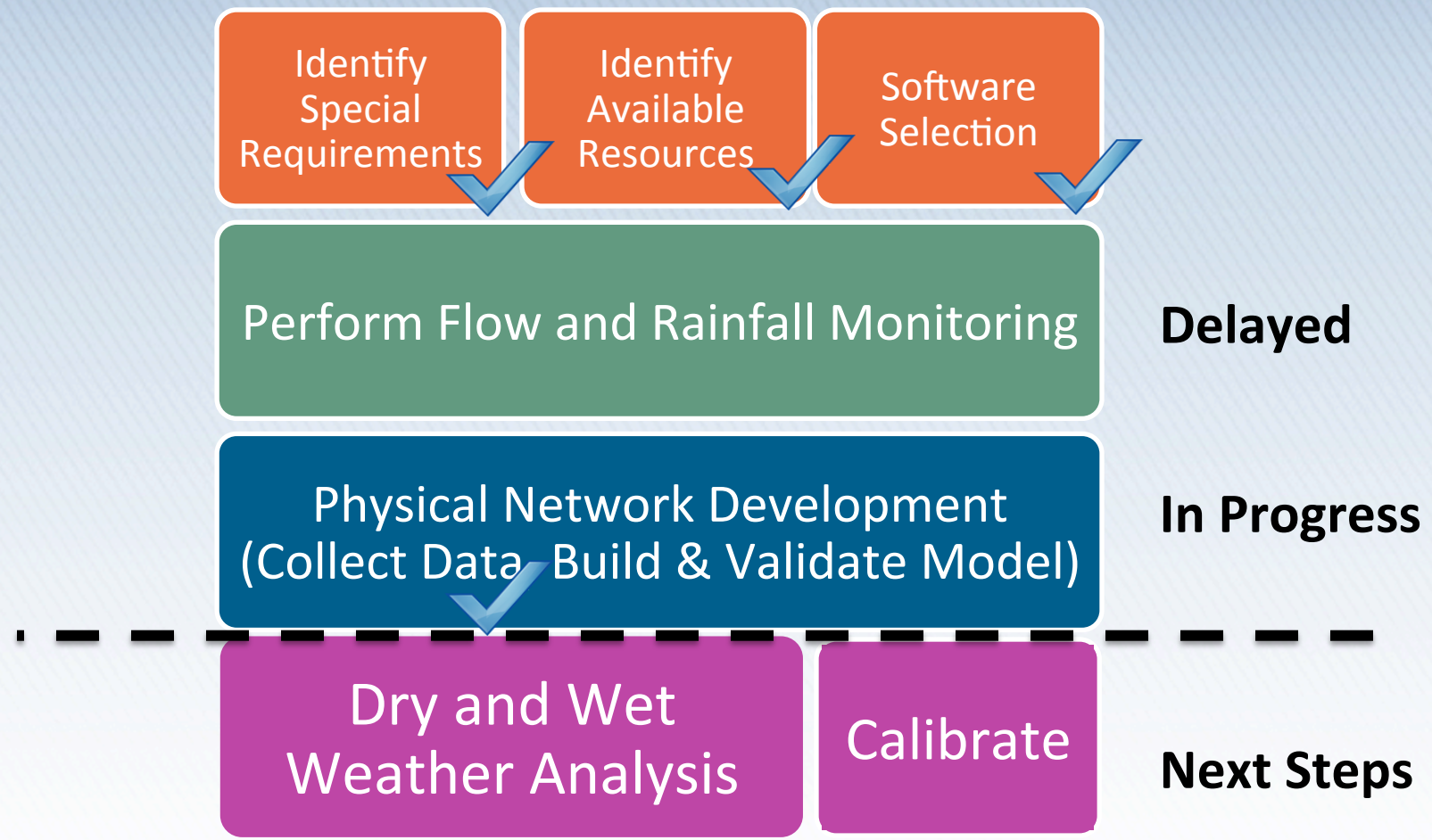
Exhibit A
Flow Monitoring, Hydraulic Modeling & Capacity Assessment Schedule
City of Fitchburg, MA

ID	Task Code	Task Name	Duration	Start	Finish
1	1	Project Management	951 days	Mon 1/20/14	Fri 9/8/17
2	1.a	Develop & Update Workplan	45 days	Mon 1/20/14	Fri 3/21/14
3	1.b	Early Coordination Meeting	5 days	Mon 1/20/14	Fri 1/24/14
4	1.c	Meetings, Minutes, Progress Reports	951 days	Mon 1/20/14	Fri 9/8/17
5	2	Model Network Data Collection	90 days	Mon 2/3/14	Fri 6/6/14
6	2.a	Obtain GIS Data, Review, and Flag Issues	45 days	Mon 2/3/14	Fri 4/4/14
7	2.b	Field Collect Data	30 days	Mon 4/28/14	Fri 6/6/14
8	3	Flow and Rainfall Monitoring Program	501 days	Mon 2/10/14	Mon 1/11/16
9	3.a	Review Previous Metering Efforts	10 days	Mon 2/10/14	Fri 2/21/14
10	3.b	Flow and Rainfall Monitoring Program (25 meters, 1 year)	282 days	Mon 11/3/14	Tue 12/1/15
11	3.c	Seasonal I/I Evaluation Using Sliicar	30 days	Tue 12/1/15	Mon 1/11/16
12	4	Hydraulic Modeling (Par. 41-46)	372 days	Tue 12/15/15	Tue 5/16/17
13	4.a	Model Network Development, Validation, and Representation	60 days	Tue 12/15/15	Mon 3/7/16
14	4.b	Input Flow Development	45 days	Mon 1/4/16	Fri 3/4/16
15	4.c	Calibration and Verification	120 days	Mon 3/7/16	Fri 8/19/16
19	4.d	Evaluate Design Storms (12 simulations)	45 days	Wed 8/24/16	Tue 10/25/16
20	4.e	Prepare Draft Modeling Report (Par. 41)	90 days	Mon 10/31/16	Thu 3/2/17
21		City Review Modeling Report	10 days	Fri 3/3/17	Thu 3/16/17
22	4.f	Prepare Final Report	30 days	Fri 3/10/17	Thu 4/20/17
23		Deliver Final Model	1 day	Mon 4/3/17	Mon 4/3/17
24		Submit Modal Report to MaDEP/EPA	1 day	Mon 5/1/17	Mon 5/1/17
25	4.g	Prepare/Submit PCMR to MaDEP/EPA (3 simulations)	45 days	Wed 3/15/17	Tue 5/16/17
26	5	Capacity Assessment (Par. 47)	135 days	Mon 7/10/17	Fri 1/12/18
27	5.a	Compare Conditions/Identify Deficiencies	35 days	Mon 7/10/17	Fri 8/25/17
28	5.b	Evaluate Future Planned Improvements (3 simulations)	30 days	Mon 8/28/17	Fri 10/6/17
29	5.c	Prepare Draft Capacity Assessment Report	30 days	Mon 10/9/17	Fri 11/17/17
30		City Review Report	10 days	Mon 11/20/17	Fri 12/1/17
31	5.d	Prepare Final Capacity Assessment Report	30 days	Mon 12/4/17	Fri 1/12/18



- Field data collection (4/14)
- Flow & rainfall monitoring (10/14)
- Calibration/verification (early ’16)
- DEP submittal (12/16)
- Capacity Assessment – follows DEP acceptance

Project Approach



Special Requirements

- Consent Decree (CD) Requirements
  - Size of the model – all 12-inch diameter and greater pipes
  - Number of model simulation scenarios to mitigate wet weather issues
- Other City Requirements
  - Compatibility with other software programs
  - Single user or multiple users can access software

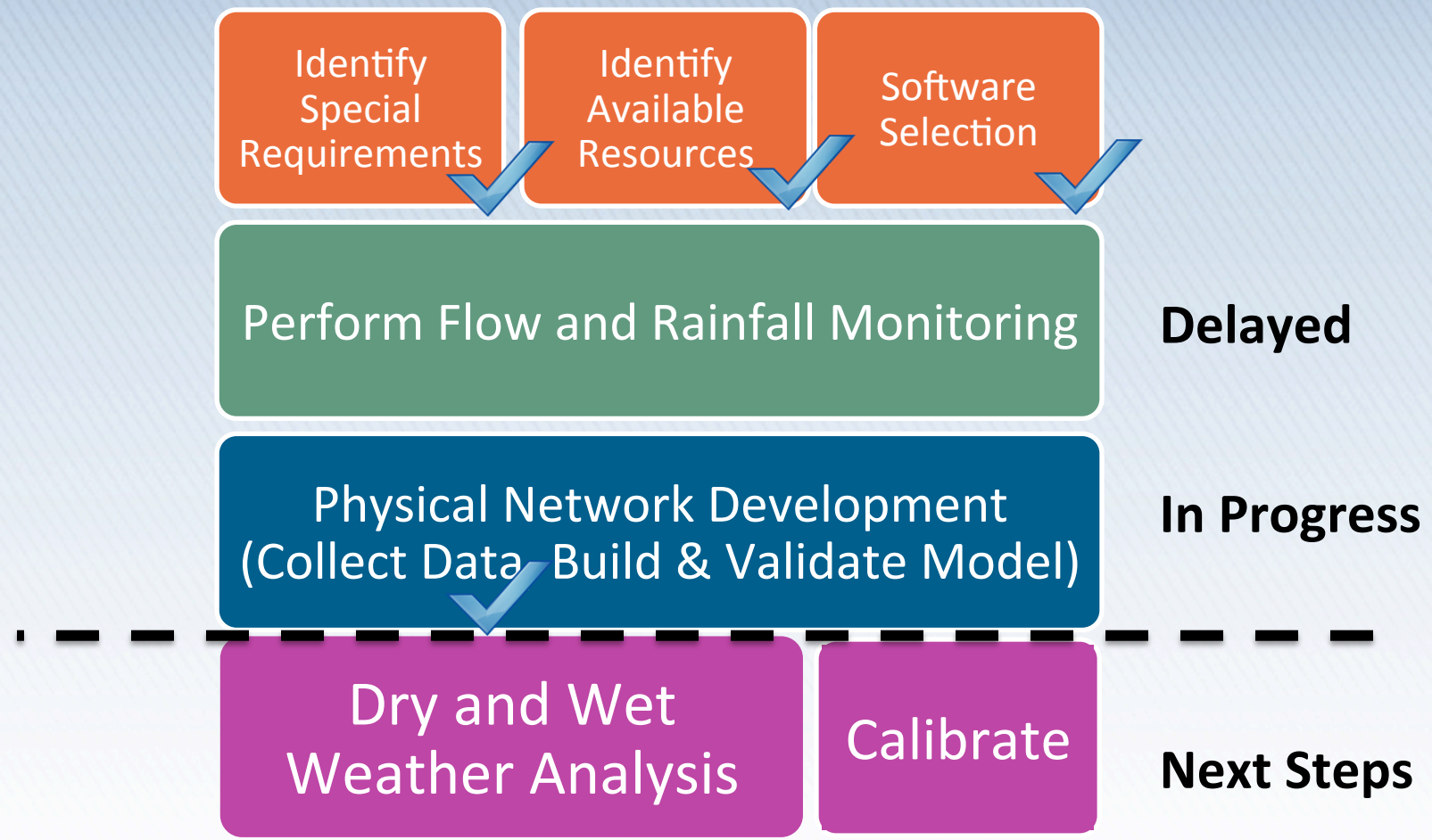
Identify Available Resources

- Dedicated staff
- Availability and accuracy of record drawings
- Existing GIS data
- Plant data (flows)
- Software (in house, consultants)
- Flow monitoring data
- Funding

Software Selection

MODEL NAME	OVERVIEW	MODEL ENGINE	INTERFACE / COMPATABILITY	Single LICENSE	ANNUAL FEE
Innovyze InfoWorks	Robust, stable, full-dynamic engine capable of efficiently modeling large data sets. Ability to manage multiple models in workgroup environment on multiple projects. Performs long-term simulations and terrific tool for reporting for capacity assurance programs.	Proprietary	ArcGIS	$18,000 (2,000 node)	$1,350
Innovyze InfoSWMM	Great for modeling combined system overflows, diversion, stormwater systems, and RDII. Ideal for utilities that have adopted GIS and want user-friendly interface. Terrific model building and verification tools.	SWMM	ArcGIS	$8,000 (2,000 node)	$1,200
Bentley SewerGEMs	Standalone option as interface. Fully dynamic, multi-platform, sanitary and combined sewer modeling solution. Built in hydraulic and hydrologic tools and a variety of wet-weather calibration methods.	Proprietary or SWMM	ArcGIS, AutoCAD or Microstation	$12,995 (2,000 node)	$1,920
MIKE URBAN -P	Models storm, sanitary and water distribution systems. Runs over GIS and includes productivity tools designed to accommodate typical work-flows and activities for urban sewer modeling.	SWMM	ArcGIS	$6,805 (unlimited)	$1,960

Where to begin… the overall approach



Flow Monitoring

- Determine Meter Locations
- Define Meter Subcatchments
- Develop Service Contract
  - To install & maintain meters fo
    1 year (By bid)

Physical Network Development

- Obtain existing GIS data
- Collect most current data by performing MH inspections
- Supplement missing data with record drawings
- Validate network (negative slopes and missing data)

Manhole Inspections

- Opening all of the manholes, which have 12-inch and larger pipes
- Photographs
- Manhole inspection forms
- Measure pipe depths
- GPS – Rim's X, Y, and Z coordinates

Field Equipment

- Equipment used during field work:
  - GPS – Leica model Viva
  - Manhole Lifter or Manhole Pick
  - Survey Rod with Pipe Mic II
  - Digital Camera

Manhole Inspections

Manhole Inspection Forms

For each manhole, a manhole inspection form was completed and included:

1. Manhole ID # and street location
2. Date and weather during inspection
3. Photographs
4. Pipe connections / connectivity (size, material, depth)

WRIGHT-PIERCE
MANHOLE INSPECTION REPORT

Project Name: Fitchburg Hydraulic Modeling

Subsystem Name/No.

Manhole ID No. 02-12-050

PROJECT LOCATION: Fitchburg, MA PROJECT NO.: 12852A

DATE: 6/4/14 WEATHER: Fair TIME: 8:55 INSPECTOR: ACH

LOCATION DATA:

STREET Fulton ST @ Doane ST (Address # & Street or Closest Intersection)

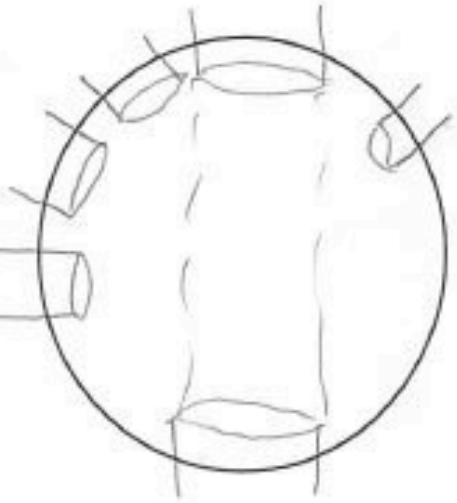
BURIED: Yes/No PAVED AREA: Yes/No

EVIDENCE SURCHARGE Yes/No ROUGH DEPTH: ___

MH DIAMETER: 4 ft 5 ft 6 ft 8 ft Other ___

PIPE (IN/OUT)	POSITION ON CLOCK	DIAM. (IN)	DEPTH TO INVERT (FT)	TOP OF PIPE MIC II (FT)*	PIPE MATERIAL
OUT	6	12	9.33	8.68	VC
IN	12	12	9.16	8.55	VC
IN	11	8	4.69	4.27	VC
IN	10	10	8.14	7.46	VC
IN	9	8	4.79	4.36	VC
IN	2	6	5.65		PVC

CB's



Manhole Photographs

For each manhole, a minimum of three photographs were taken:

1. Top of manhole with ID # on dry erase board
2. Top/down view of the bench with the outgoing pipe at 6 o'clock
3. General vicinity view to locate the manhole

Photo #1

Photo #2

Photo #3

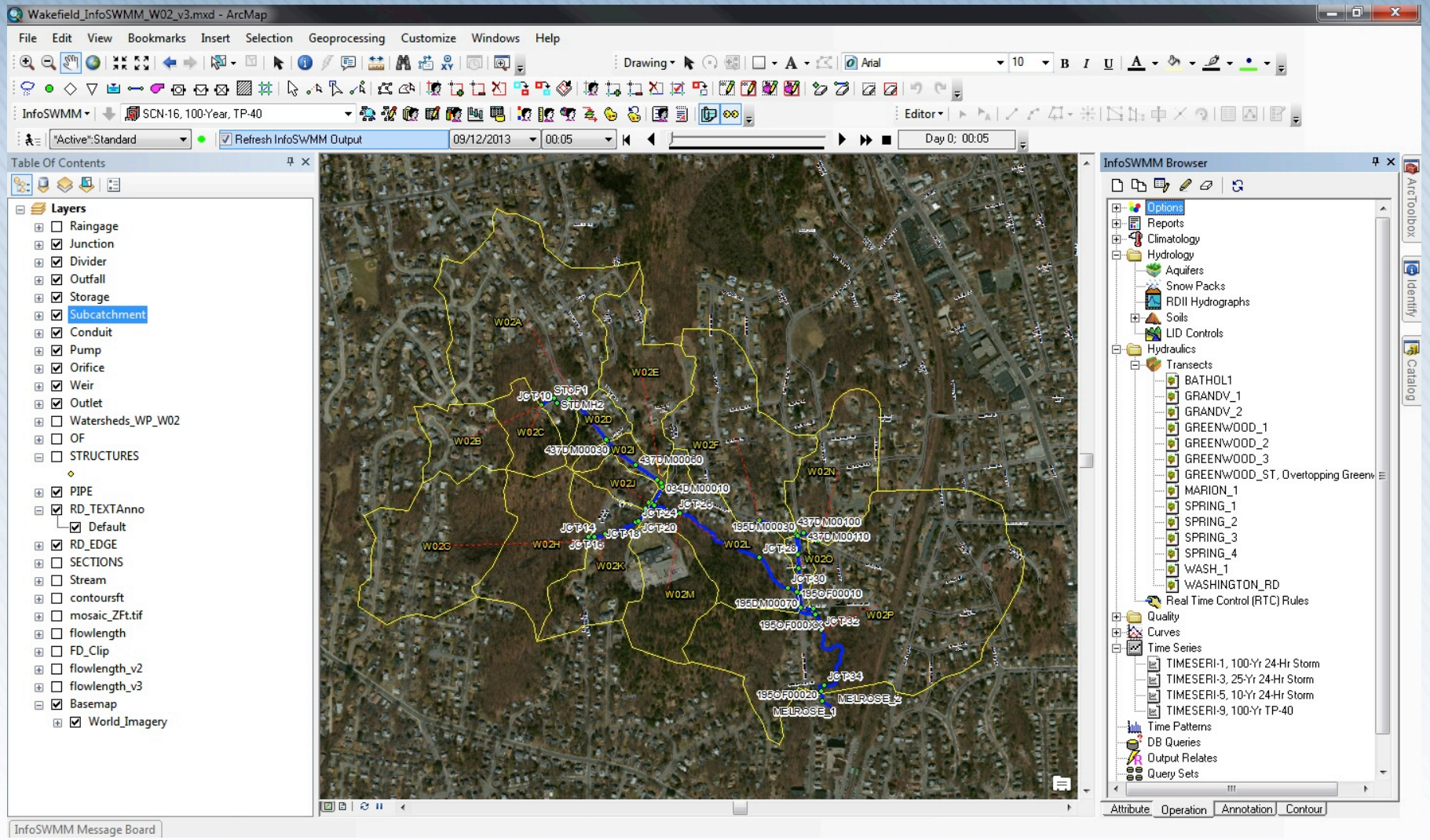
QA/QC Processes

- Wright-Pierce QA/QC
  - Checked sketches with the photographs
  - Compared data to latest GIS data
- City of Fitchburg QA/QC
  - Revised manhole photograph naming
  - Compared pictures to the GIS data
  - Determined where data gaps still existed
  - City finalized its GIS data, and turned it over to W-P

Populating the Model with Field Data

- City GIS data was basis of physical model
- Updating GIS data using field data
  - Track changes so City is aware
  - Determine if need to perform more field work or pull from existing information

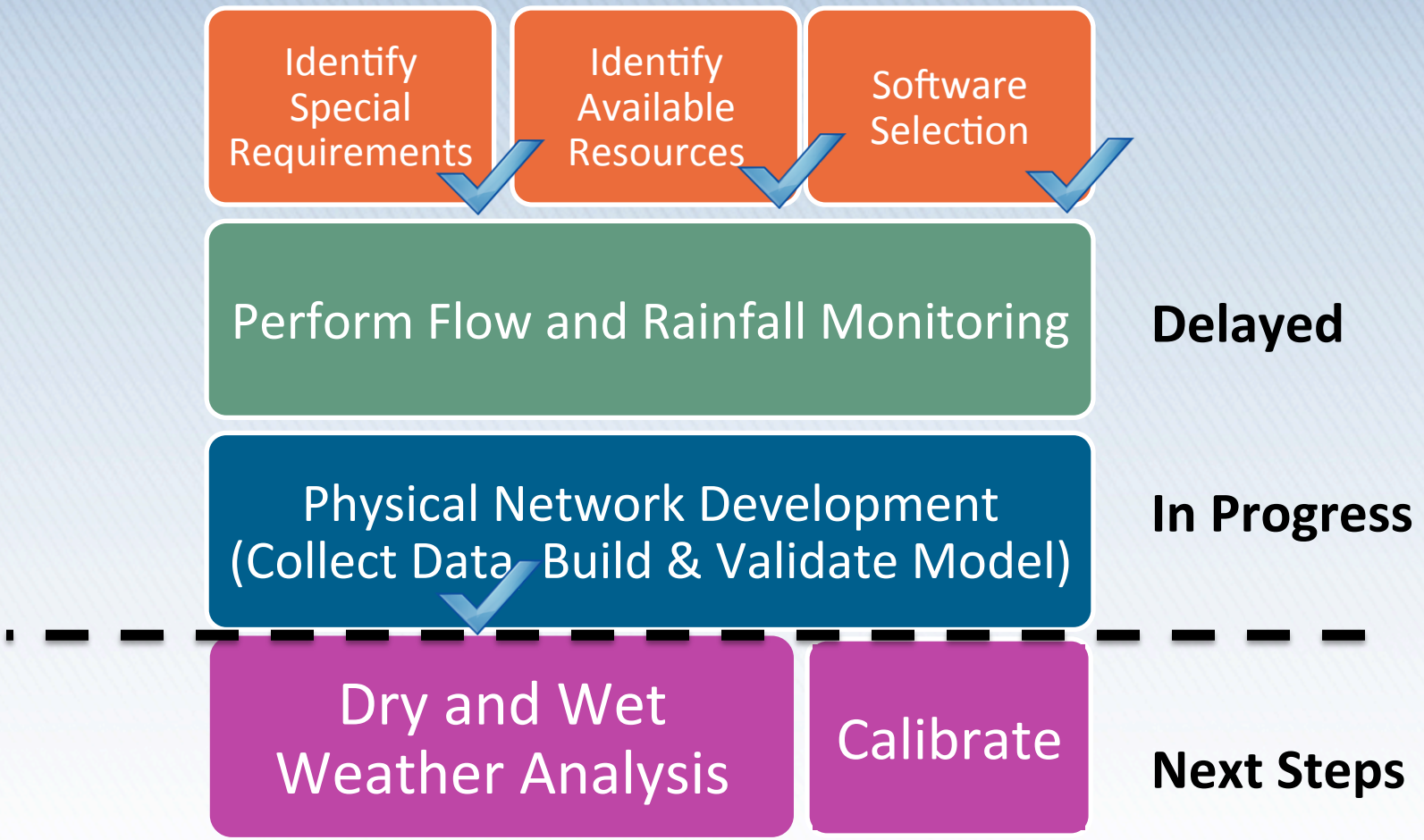
Physical Hydraulic Model



Model Validation

- Validation is concerned with building the ***right model***
- It is utilized to determine that a model is an accurate representation of the real system
- W-P will validate the model prior to running any simulations by addressing the list of errors or warnings, output by InfoSWMM
  - Negative slope

Where to begin…
the overall approach



Next Steps

- Flow monitoring
- Seasonal I/I Analysis (ADS Sliicer)
- Calibrate the model
- Verify the model
- Run up to 12 model simulations
  - Existing conditions (base flow)
  - Storm events (peak flows)
- Identify hydraulic deficiencies
- Run 3 model simulation scenarios that evaluate future planned improvements to mitigate wet weather issues
- Prepare Model Report for MassDEP and EPA (includes Capacity Assessment Report and PCMR)

Take Away / Lessons Learned

- Balancing manhole inspection effort/level of detail with budget
  - For model vs. CMOM
- Bring all necessary equipment (ex. wrench, tool to clean clogged pipes)
- Photograph management is critical (ex. naming convention)
- To avoid being overwhelmed, go basin by basin rather than attacking the whole model at one time

Thank you …

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Wright-Pierce: Paul Birkel and Barry Yaceshyn

Questions / Discussions