1.782 Environmental Engineering Masters of Engineering Project
Fall 2007 - Spring 2008

MAE LA REFUGEE CAMP WATER SUPPLY

25 April 2008

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MIT - CEE

Master of Engineering

MAE LA REFUGEE CAMP WATER SYSTEM

- Background and Overview
- Distribution System Modeling
- Distribution System Mapping
- Water Treatment

MAE LA REFUGEE CAMP

Figure by MIT OpenCourseWare.

- Karen, Karenni, and Mon refugees from Myanmar (Burma)
- 45,000 people

WATER SUPPLY AND GEOGRAPHY

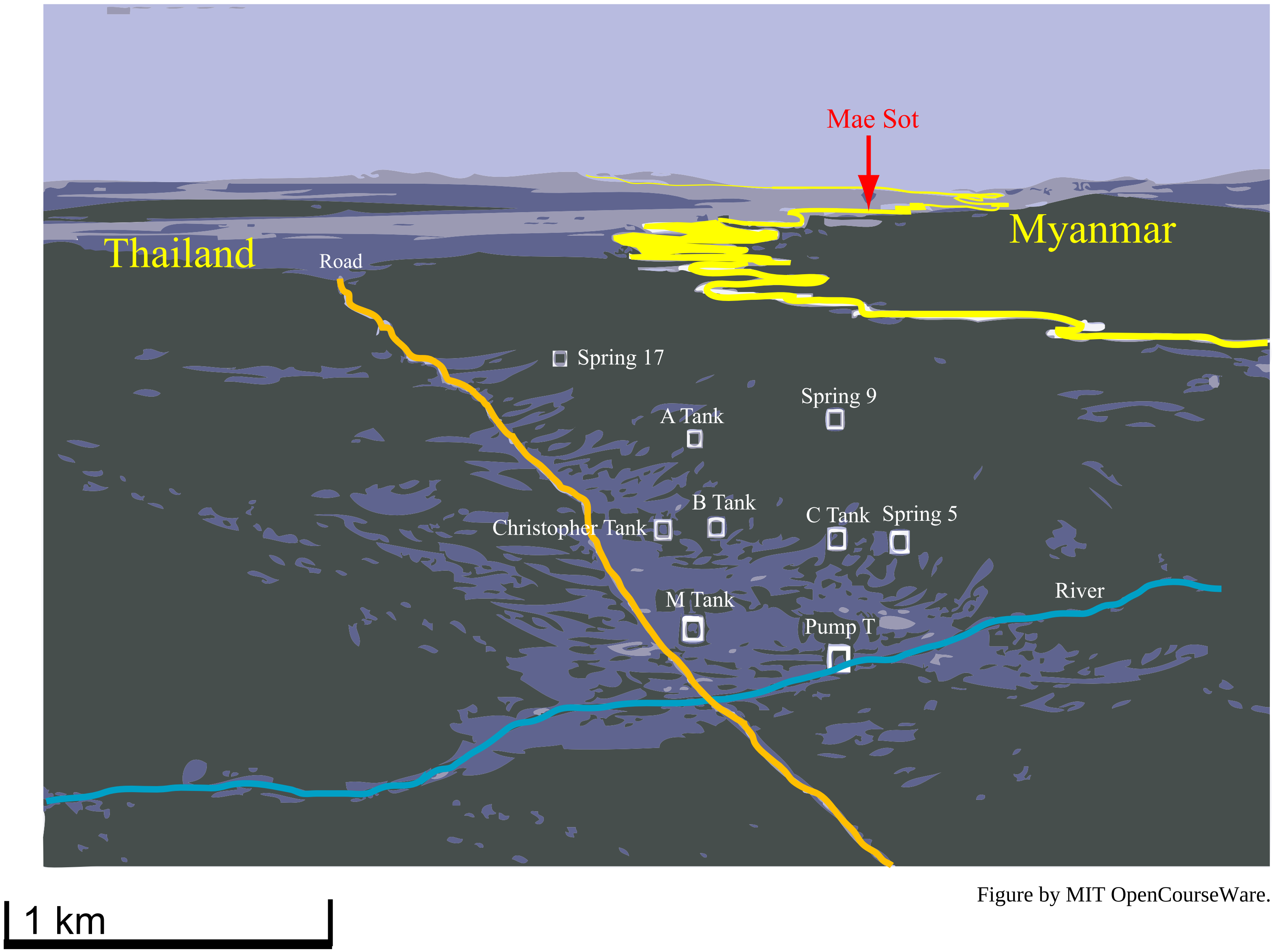
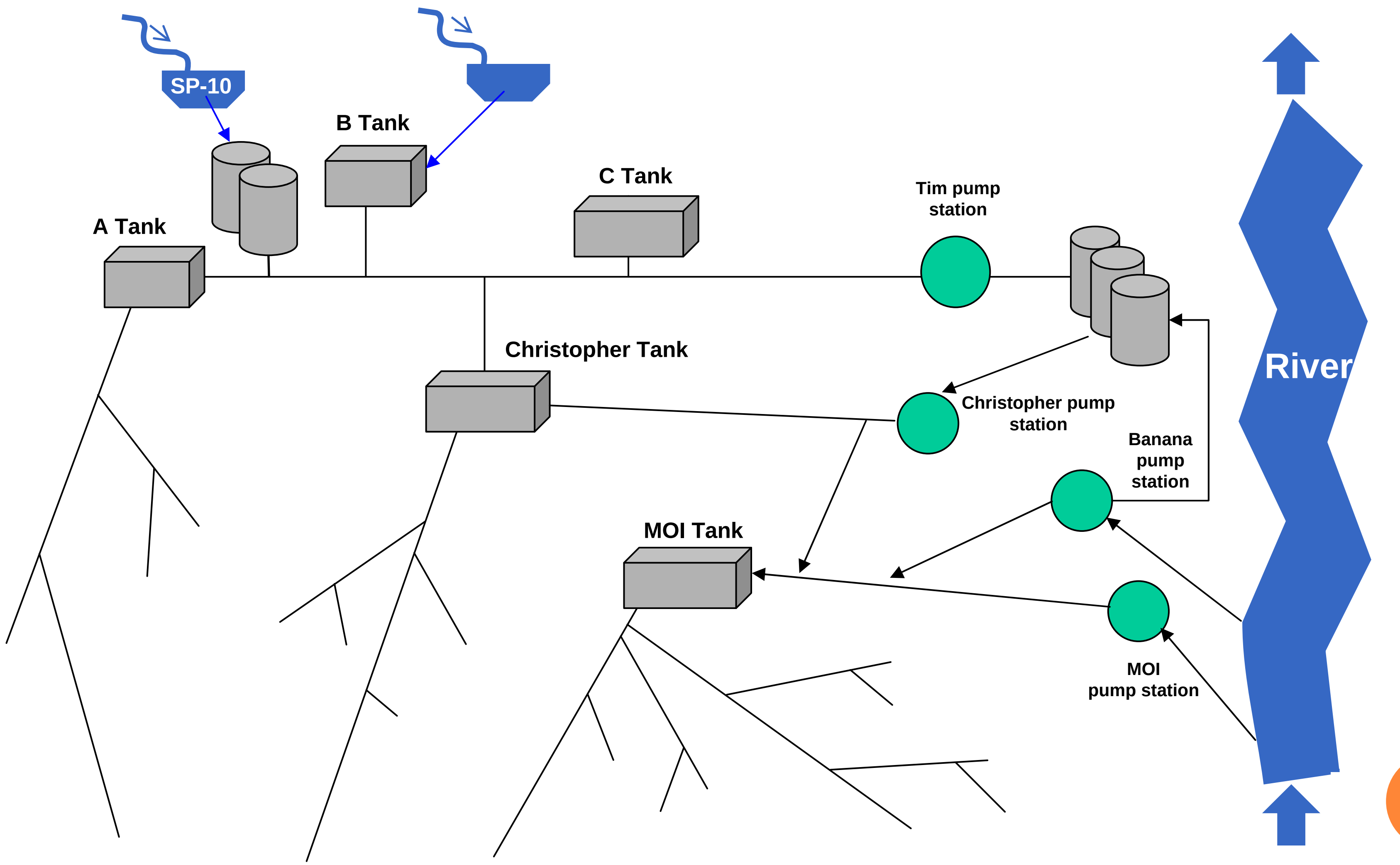


Figure by MIT OpenCourseWare.

DRINKING WATER SUPPLY OVERVIEW



SPRING WATER SYSTEM OVERVIEW

Source

Filter

Storage

Tap stands

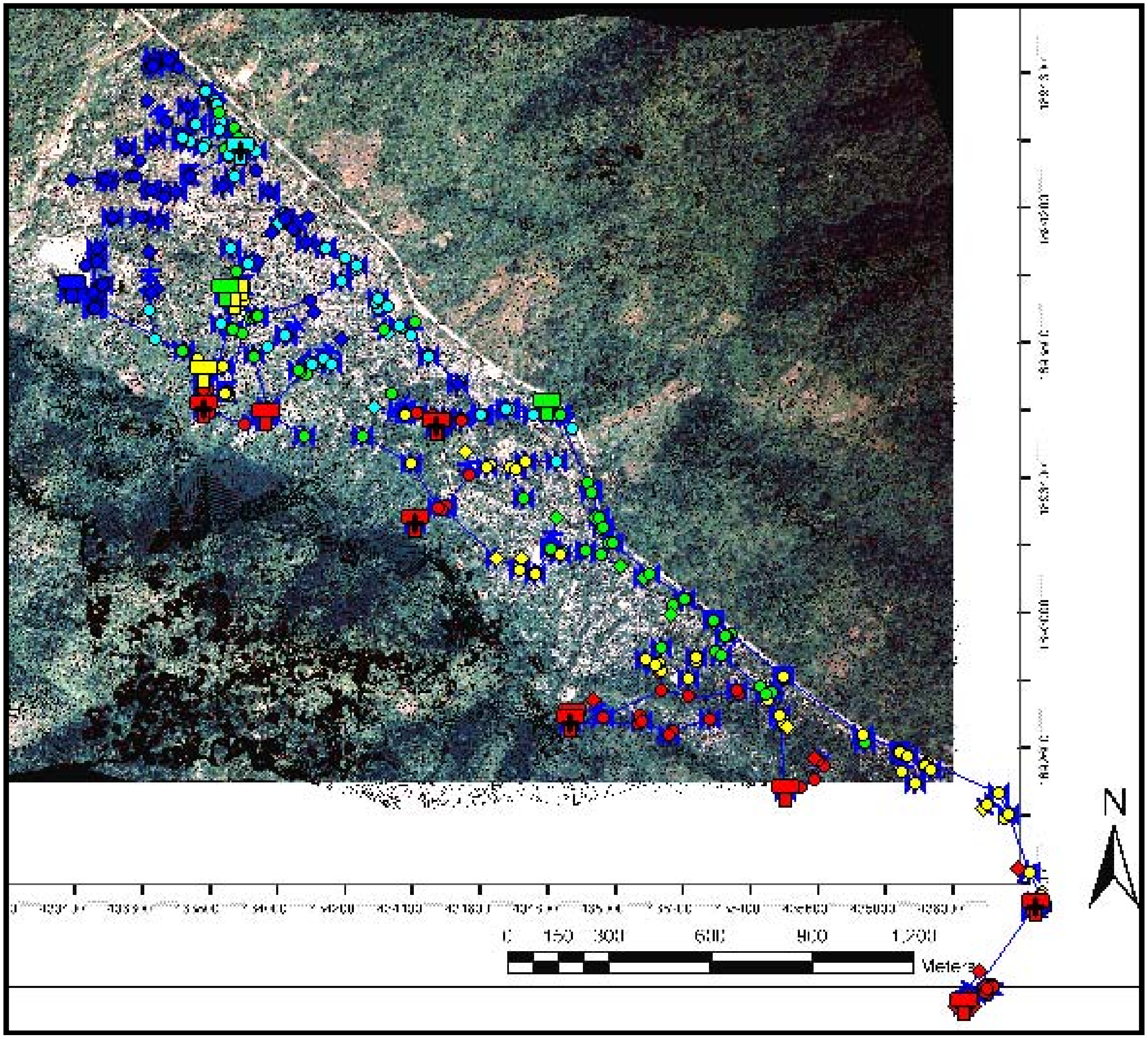
MAE LA REFUGEE CAMP WATER SYSTEM

- Background and Overview
- **Distribution System Modeling**
- Distribution System Mapping
- Water Treatment

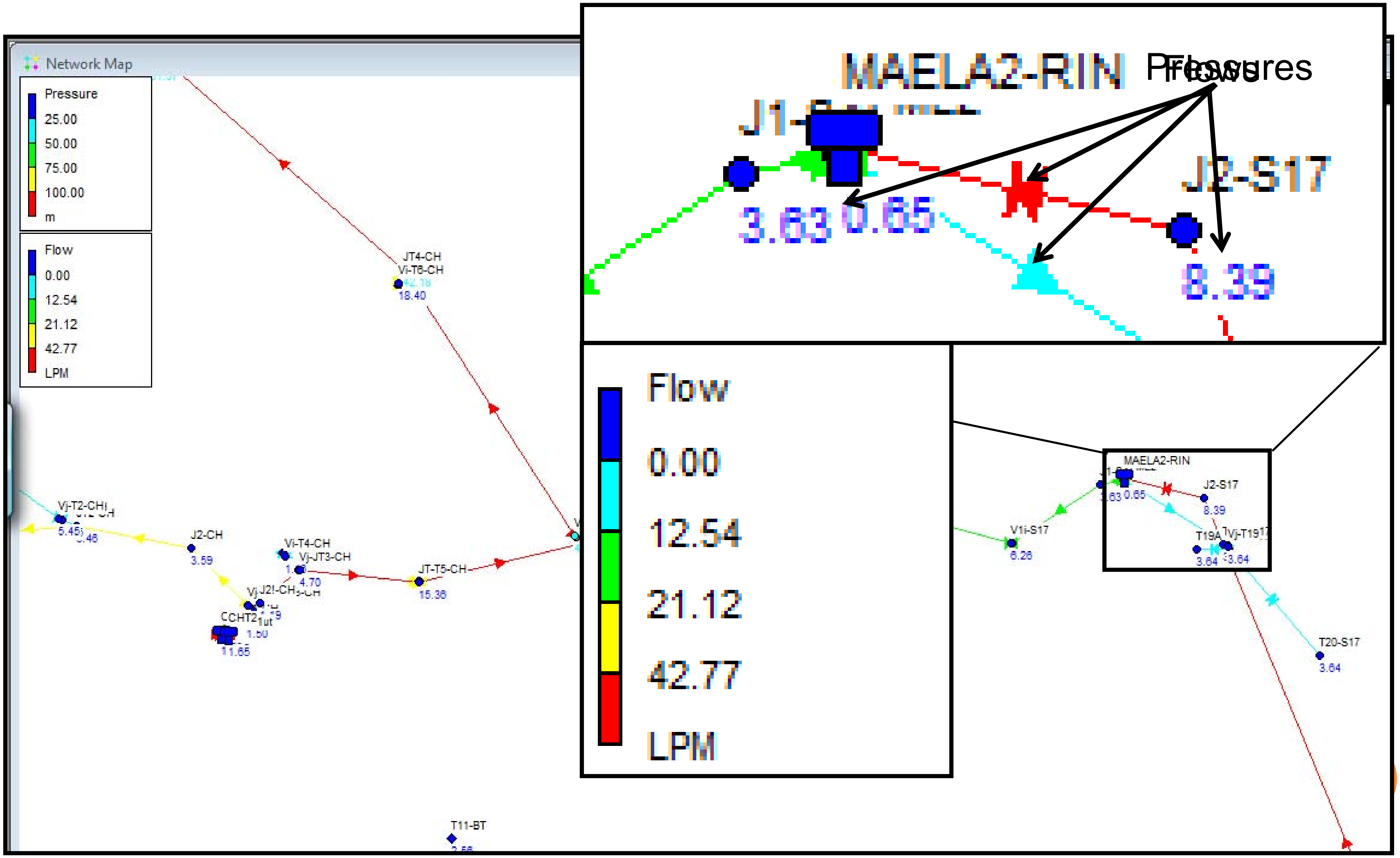
WATER DISTRIBUTION MODELING

- Illustration of EPANET
- Model calibration
- Example analysis of system modifications

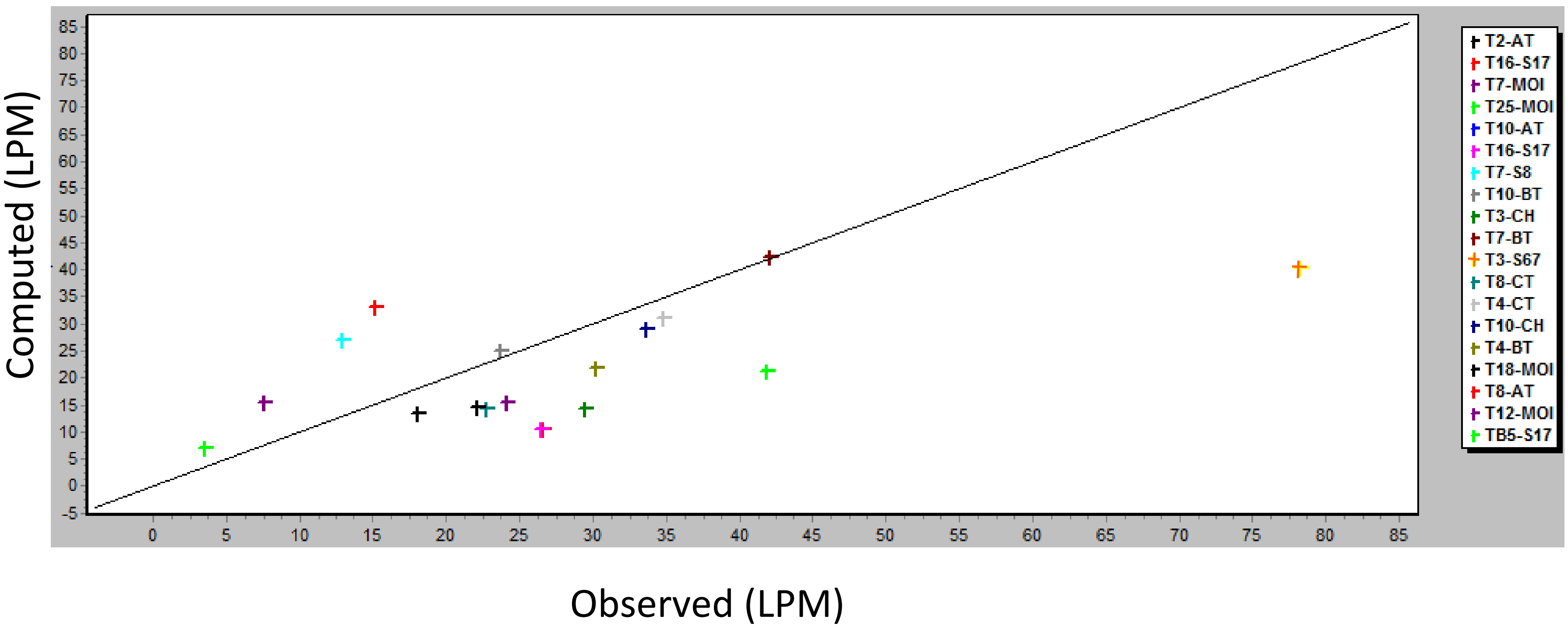
OVERALL EPANET SYSTEM



SAMPLE RESULTS

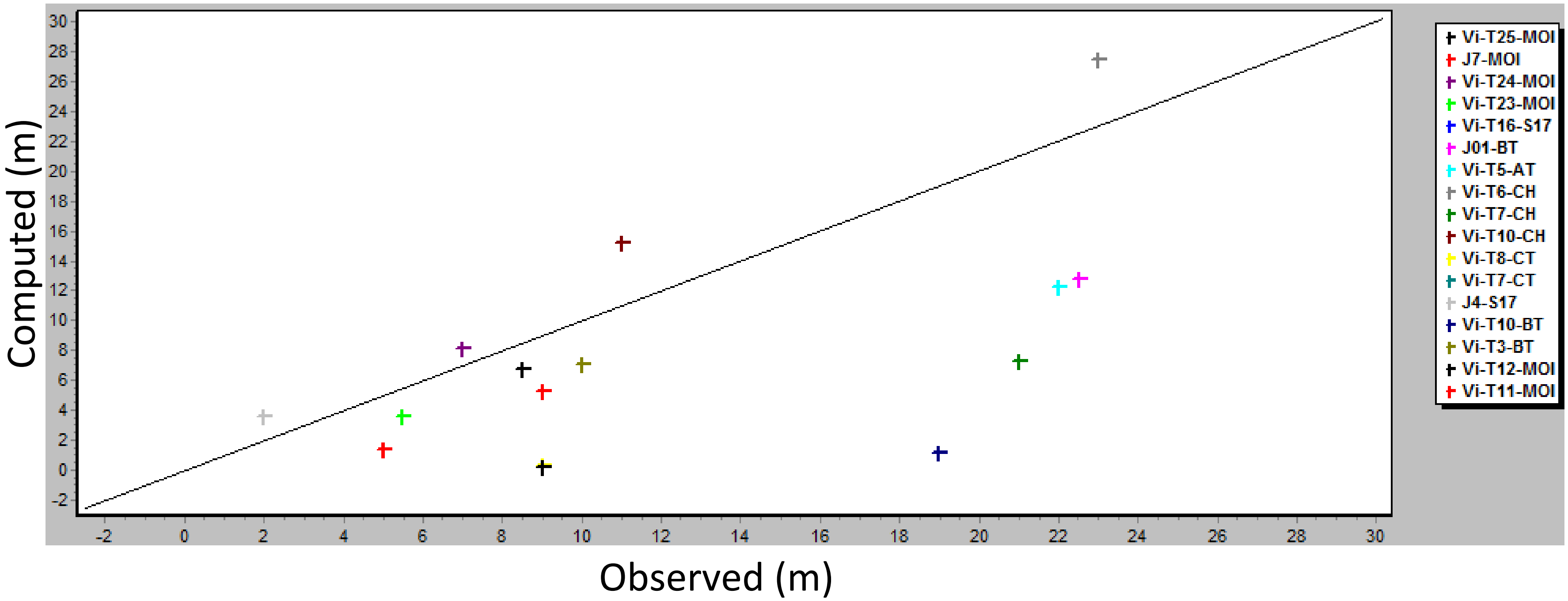


CALIBRATION OF TAP FLOW



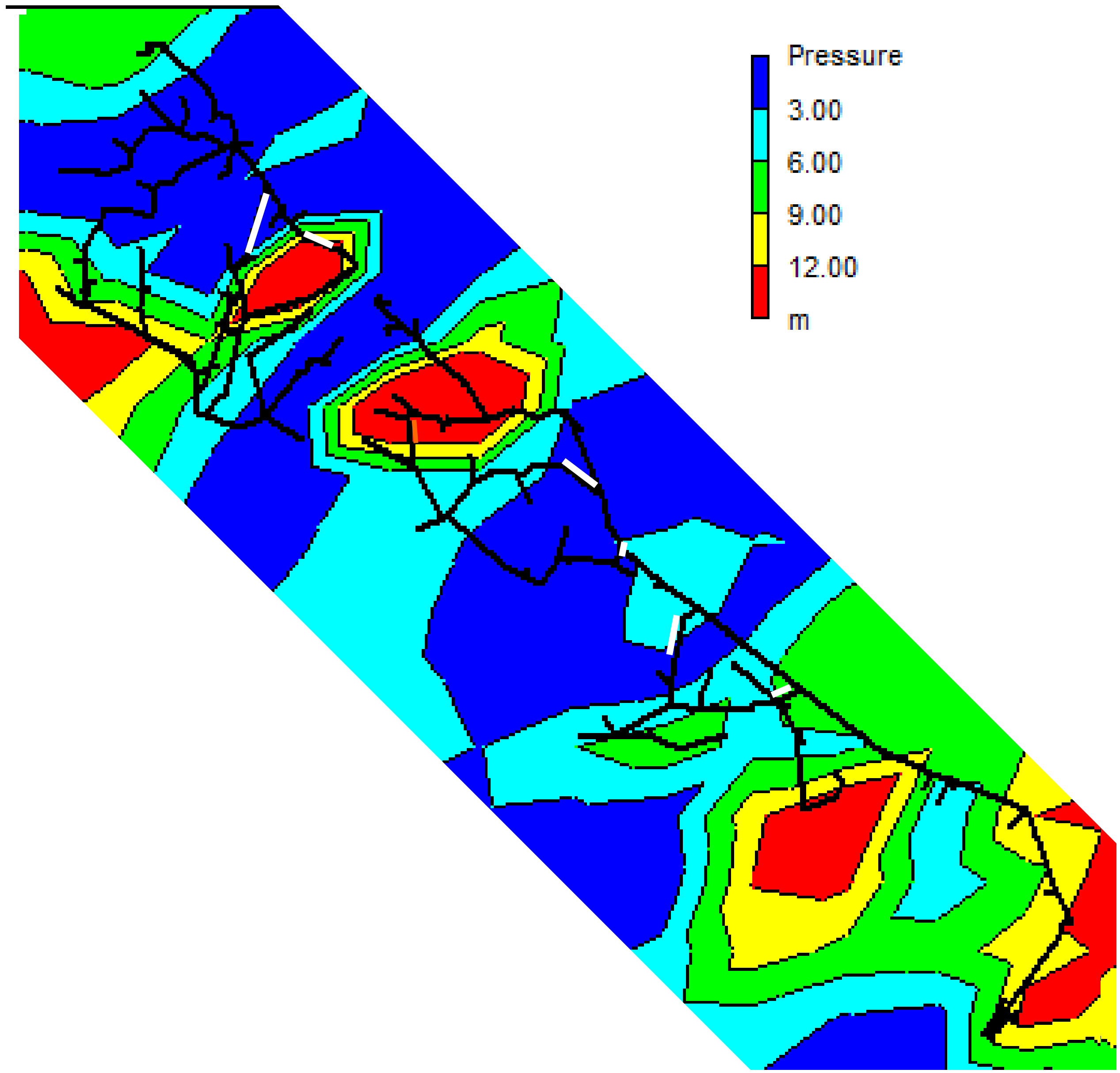
Correlation: 0.61

CALIBRATION OF PRESSURE

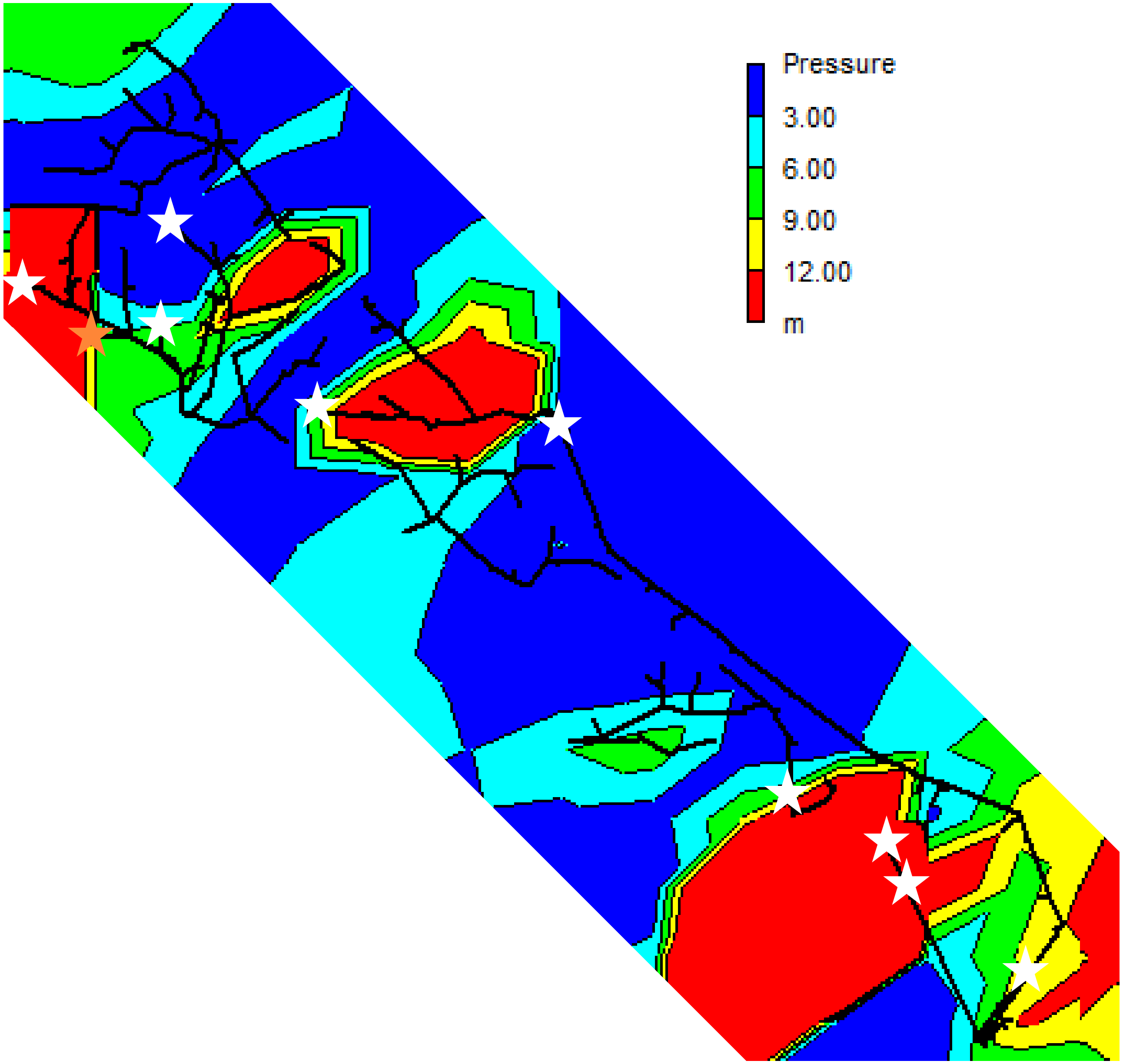


Correlation: 0.59

PRESSURE DISTRIBUTION AND LAYOUT



GEOGRAPHIAL COVERAGE: NEW TAPS



TANK LEVELS AT END OF DISTRIBUTION

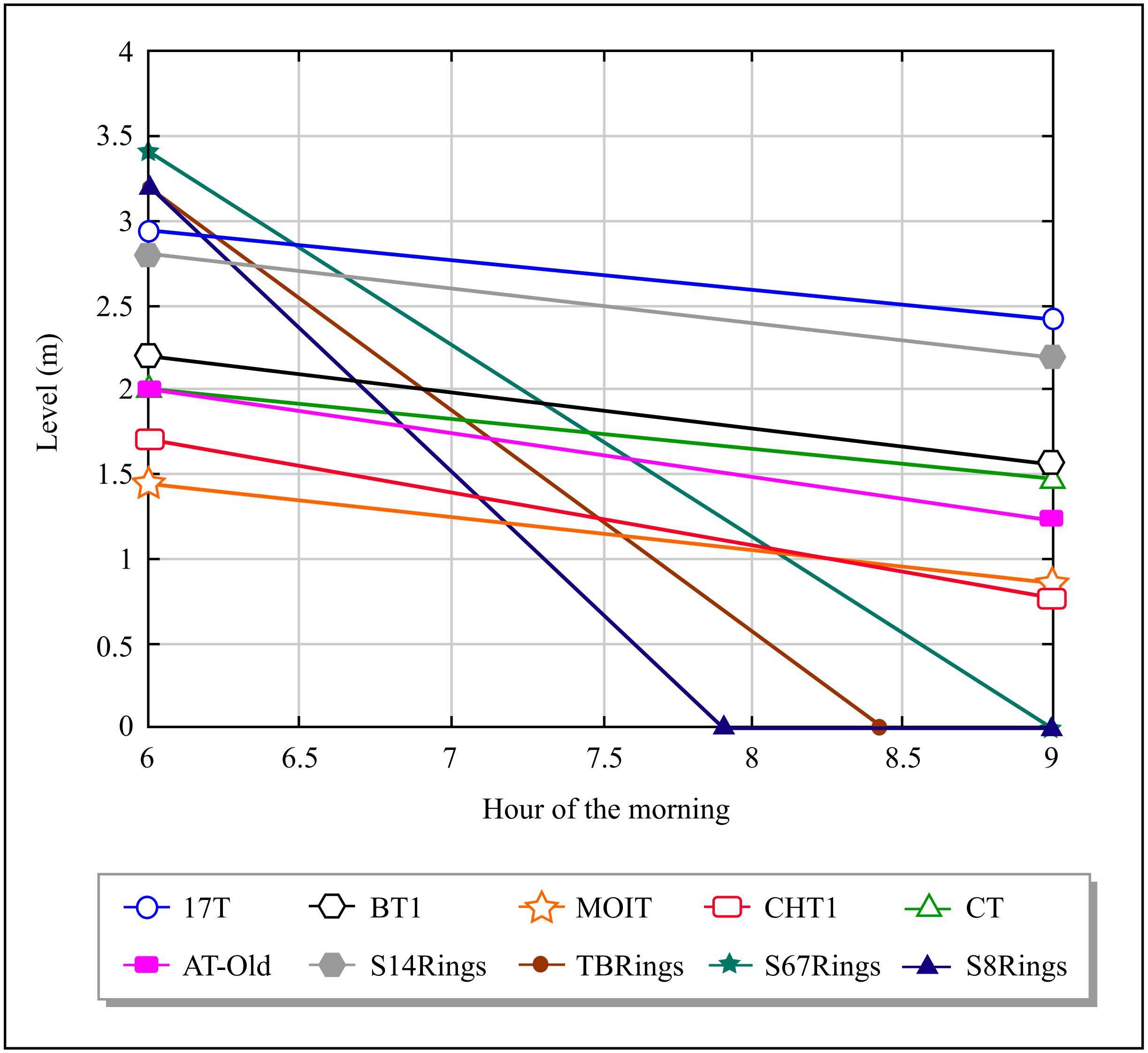


Figure by MIT OpenCourseWare.

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WATER DISTRIBUTION MAPPING

- Example visual output
- Geographical errors
- Results: Home distance to nearest tap stand
Under-service volume & time

DISTANCE OF HOMES TO NEAREST TAP

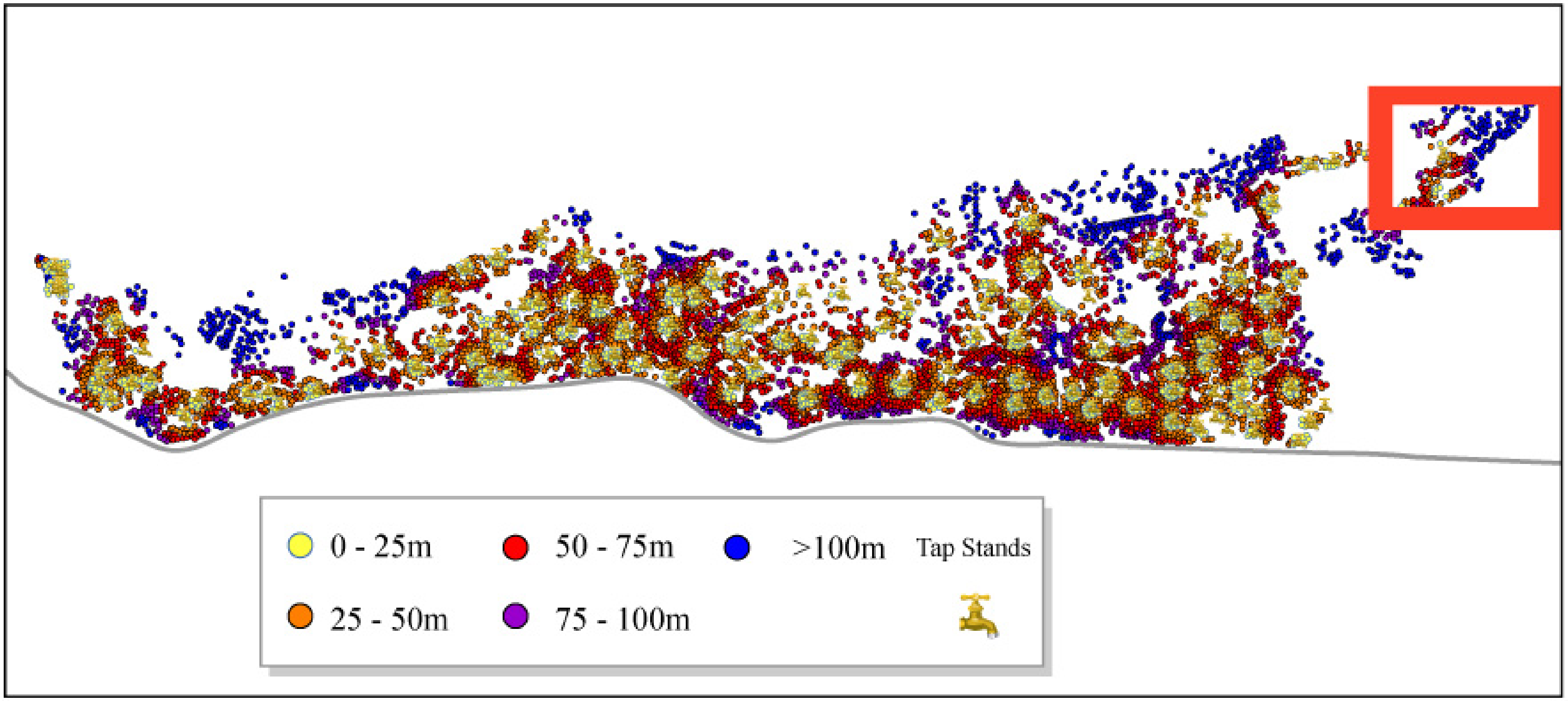


Figure by MIT OpenCourseWare.

SPRING 2 – LOW COVERAGE

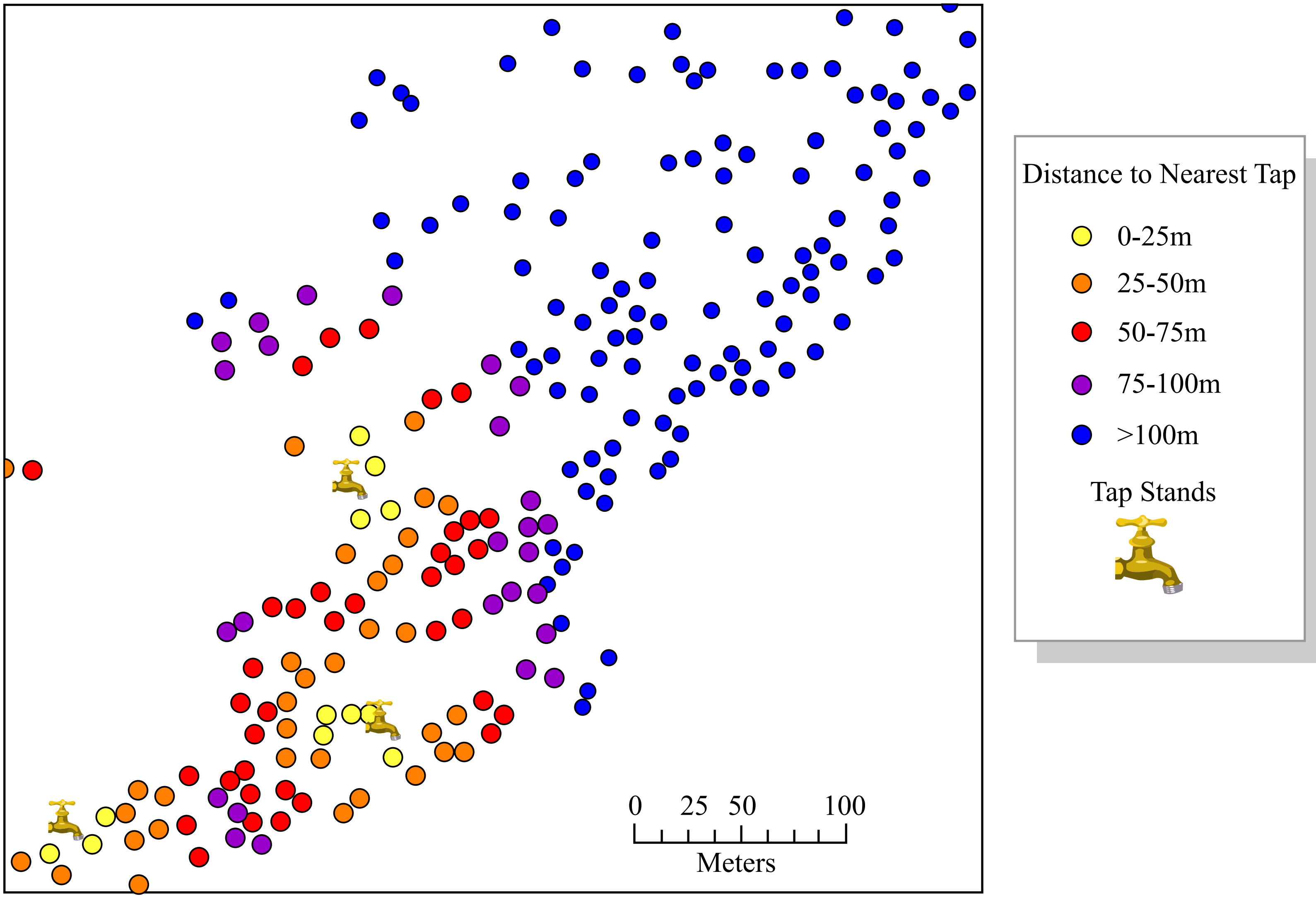
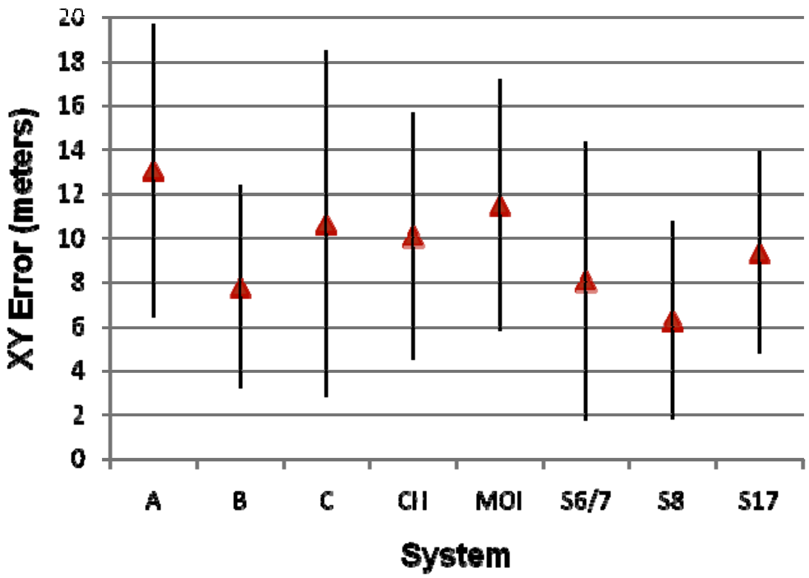
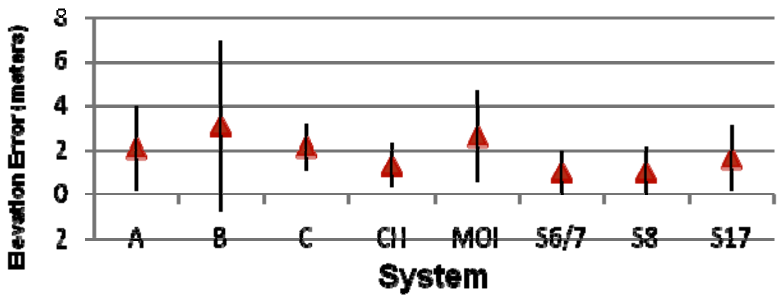


Figure by MIT OpenCourseWare.

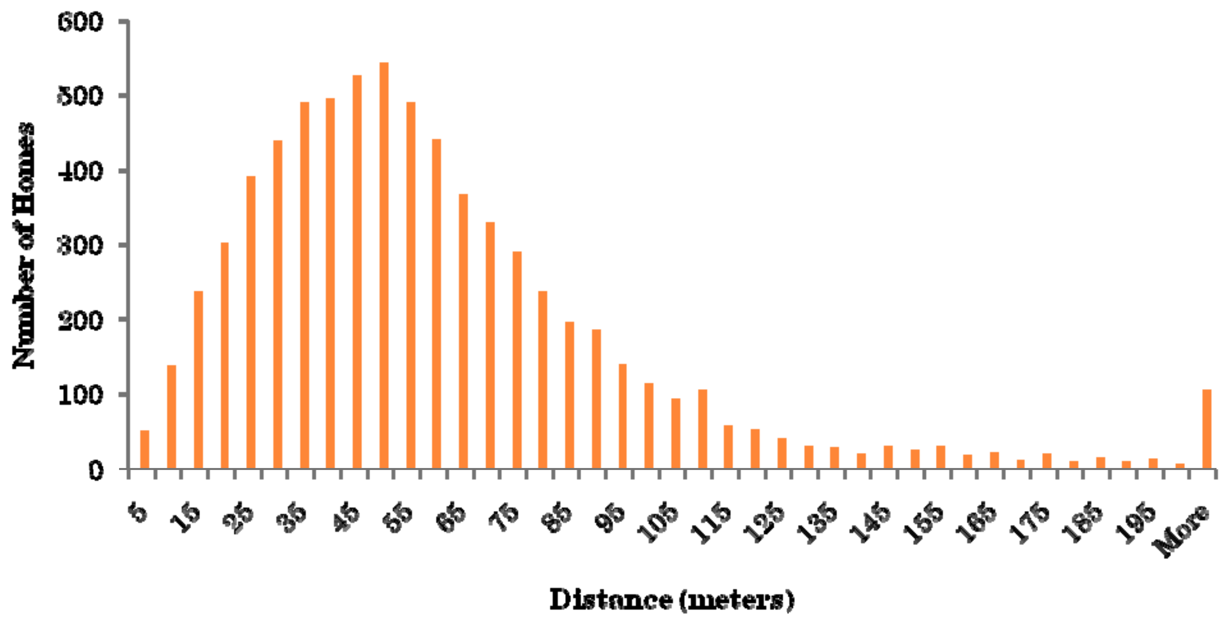
ERROR ANALYSIS





- Previous AMI tap stand location data and corresponding elevation error from DEM
- Mostly: 1-2m elevation change per 15m on land
- Closer to mountains: 10-15m change per 15m

HOME DISTANCE TO TAP STAND HISTOGRAM



- Assumes everyone gets water from closest tap
- Nearly 50% of homes within 30-60m range
- Some large outliers with distances >200m (many in SP2 region)

WATER CONSUMPTION AND TRAVEL TIMES

- Trip travel times less than ~3 mins. → increased consumption

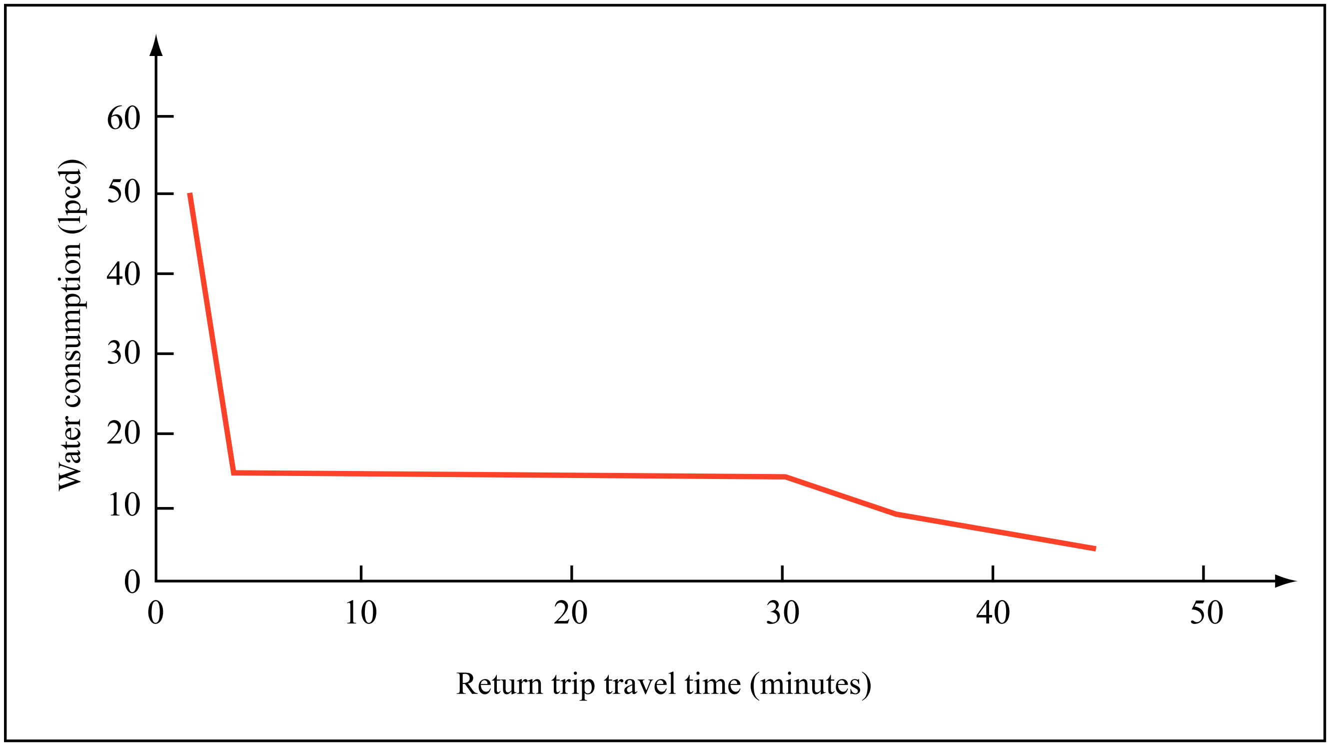
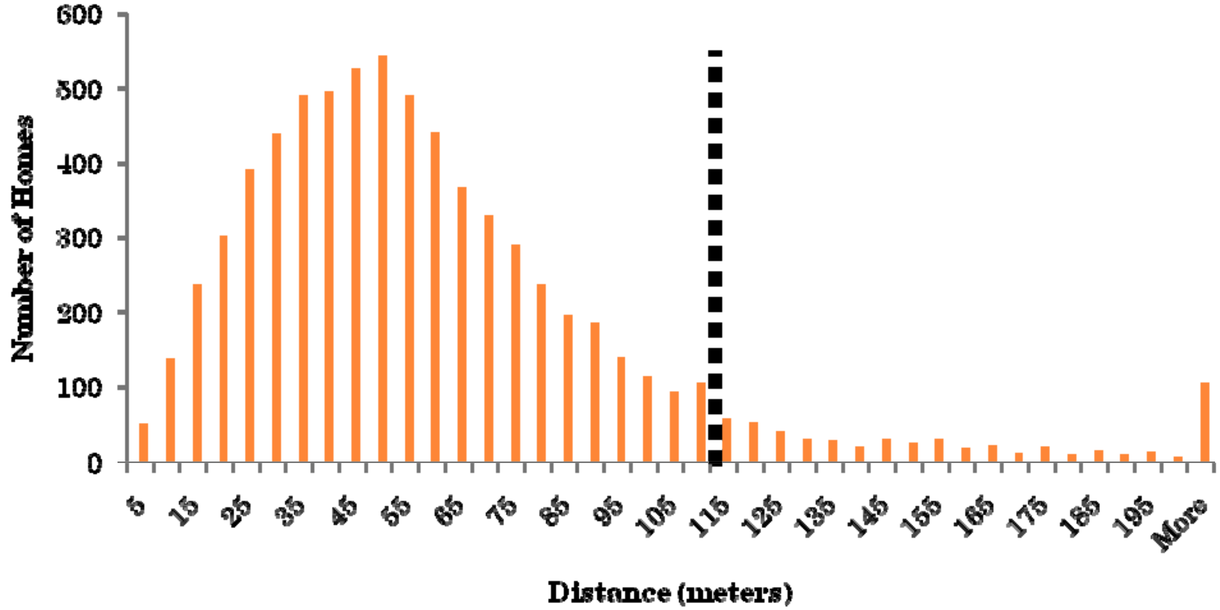


Figure by MIT OpenCourseWare.

- If tap within 1.5 min walk or **115 meters**

WELL 1998, *Guidance manual on water supply and sanitation programmes, WEDC,* Loughborough, UK.

WATER CONSUMPTION AND TRAVEL TIMES



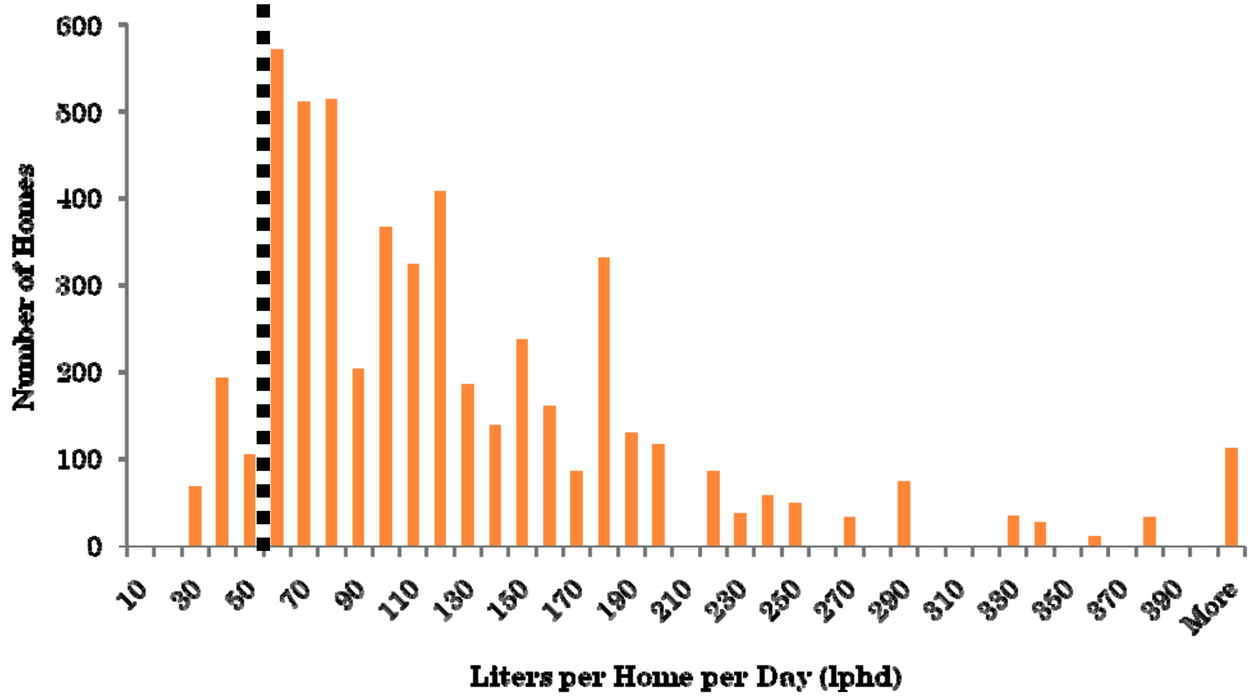
- 93% of homes have tap within 115 meters
- Excluding SP2 region, over 95% of homes

WATER VOLUME DISTRIBUTION

- Recommended minimum water consumption: 7.5 liters/capita/day (WHO)
- Assuming 6 people/home → **50 liters/home/day**

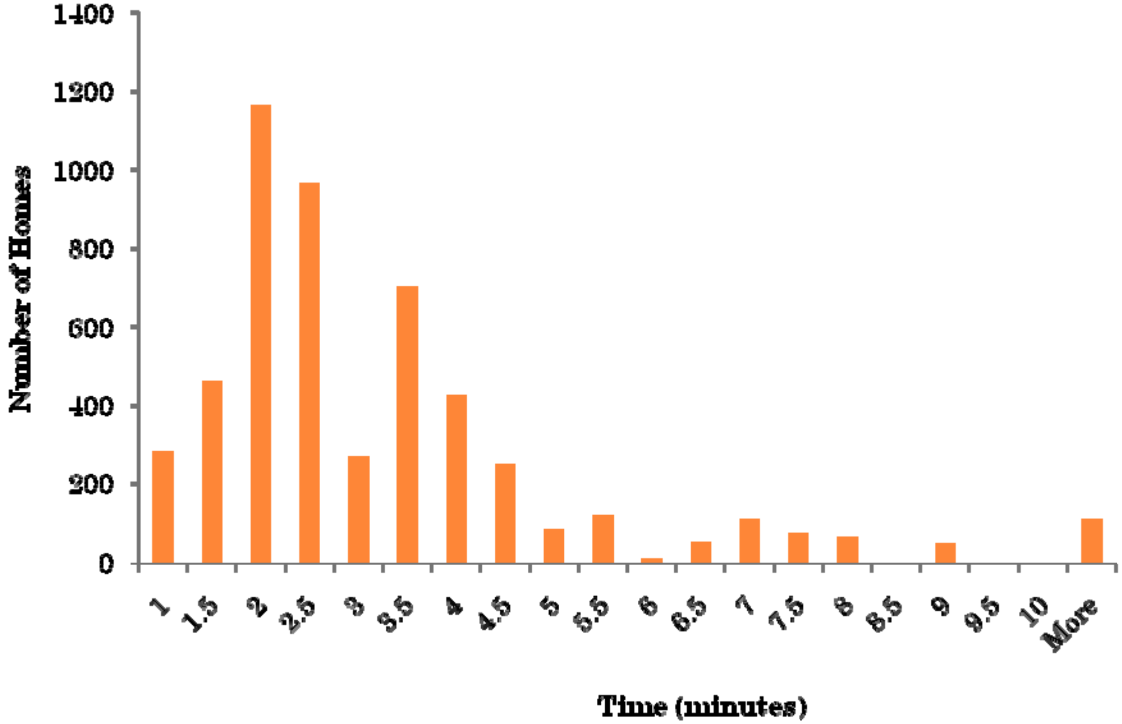
- Use EPANET model results which provides flow estimation for 88 of 129 viable tap stands

WATER VOLUME DISTRIBUTION



- 360 homes (7%) under-serviced
- 6 of 88 tap stands

TIME TO COLLECT 50 LITERS



- Compare to available collection time/home
- Based on taps/stand and population density
- Under-serviced: additional 180 homes
- Increase to 10% of homes (from 7% volume)

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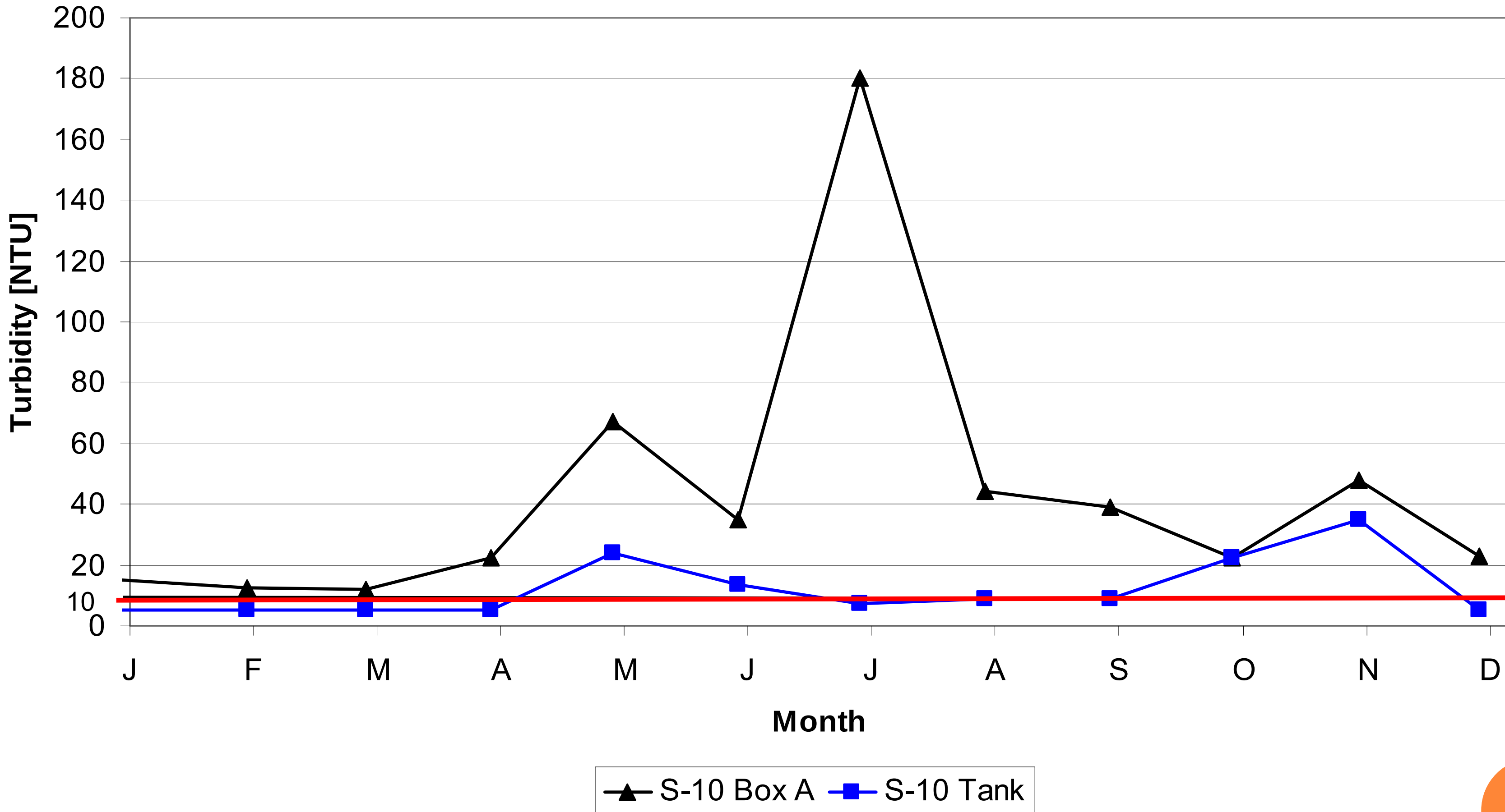
EXISTING WATER TREATMENT

- Disinfection by chlorination
  - Effective chlorination requires low turbidity levels
  - Treatment goal: Turbidity $\leq$ 10 NTU
- Horizontal-flow roughing filter at Spring 10

WATER TREATMENT OBJECTIVES

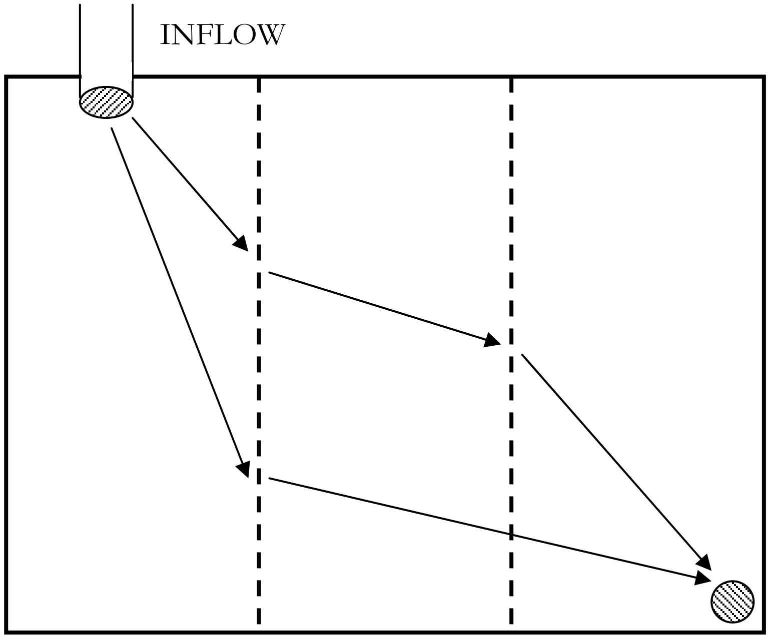
- Study effectiveness of existing filter
  - Improve the filter
- Design a general filter for other springs
- Determine necessary maintenance

2007 TURBIDITY AT SPRING 10



EXISTING FILTER AT SPRING 10

Internal Wall of Filter

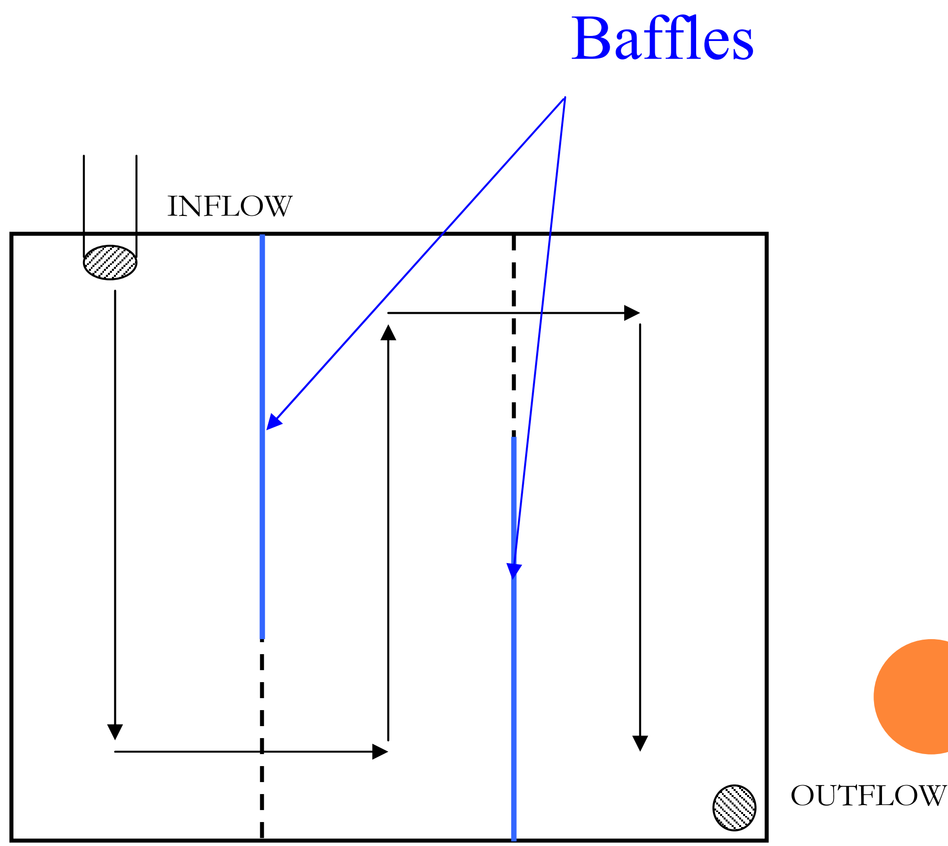


Filter Plan View:
Potential Short-circuiting

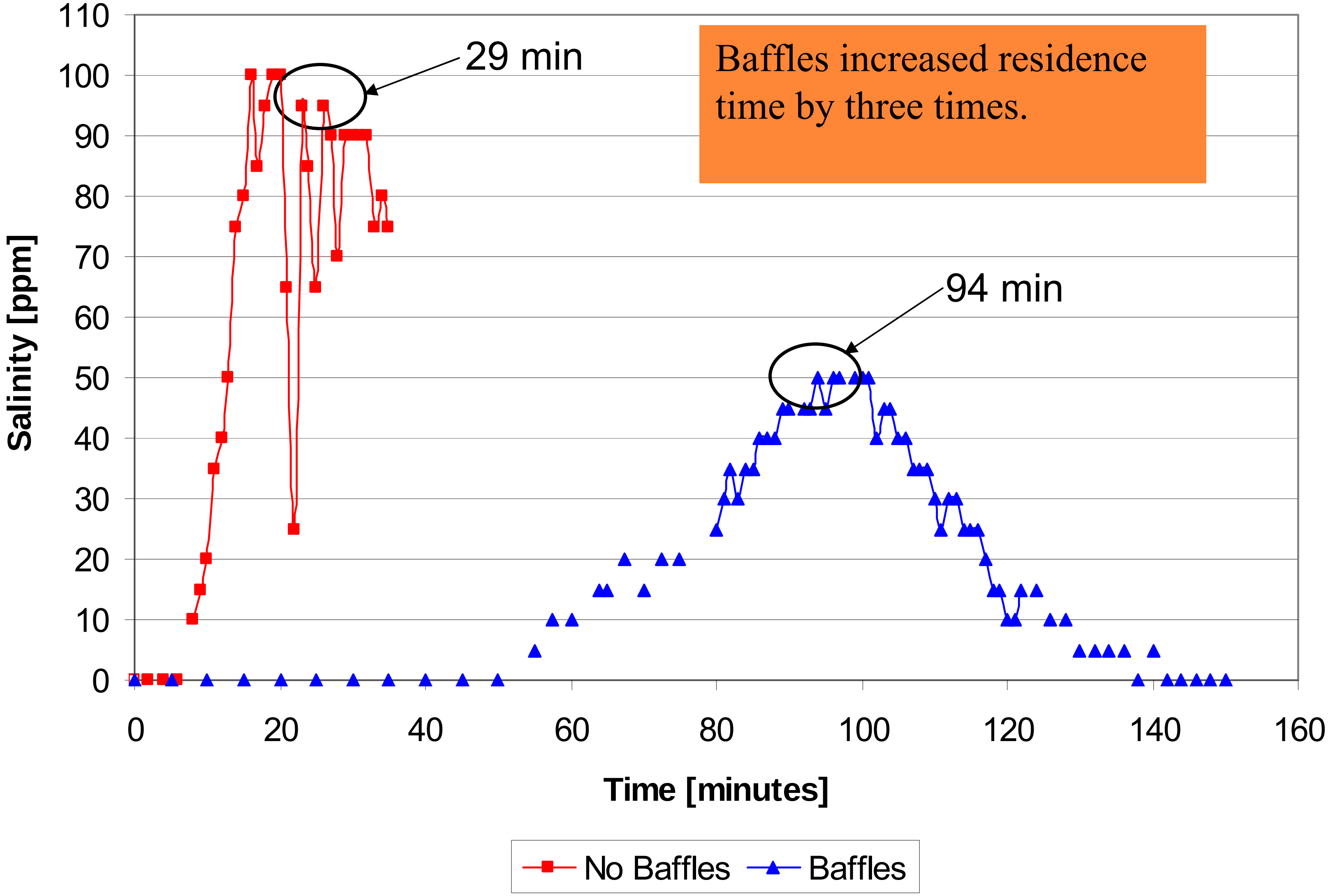
JANUARY 2008 MODIFICATIONS

Baffle Addition to Internal Walls of Filter

Filter Plan View: New Flow Path



RELATIVE FLOW TEST RESULTS



TURBIDITY SAMPLING

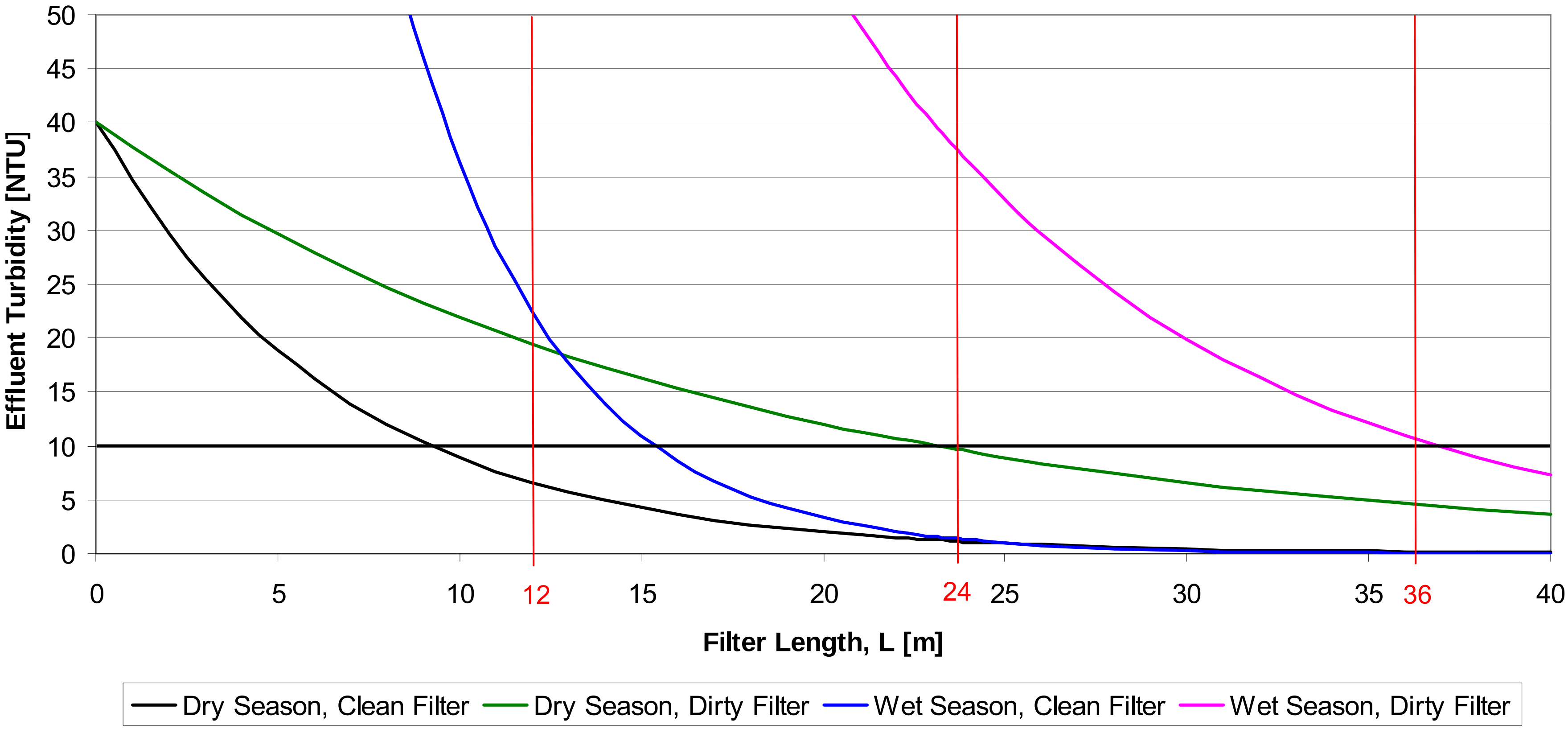
Flow Scenario	**C_o [NTU]**	**C_e [NTU]**
Dry season, clean filter	38	6
Dry season, dirty filter	30	14
Wet season simulation, clean filter	240	14

COEFFICIENT OF FILTRATION, Λ

$$E = \frac{C_e}{C_o} = e^{-\lambda L}$$

Flow Scenario	**C_o [NTU]**	**C_e [NTU]**	**Λ [m^{-1}]**
Dry season, clean filter	38	6	0.15
Dry season, dirty filter	30	14	0.06
Wet season simulation, clean filter	240	14	0.24
Wet season, dirty filter (extrapolation)	--	--	0.10

ACHIEVING C_E < 10 NTU BY LENGTHENING FILTER



CONCLUSIONS

- Spring 10 Filter Improvements
  - Construct second filter
  - Install outlet weirs
- General Filter Design
  - Not recommendable
- Filter Maintenance
  - Monitor turbidity
  - Clean the filter based on monitoring

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2007 FLOW VOLUME BY SPRING