King County

# Barton, Murray, Magnolia, and North Beach

# Murray Technical Workshop
# June 19, 2010

## CSO Facilities

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Engineers...Working Wonders With Water™

TETRA TECH

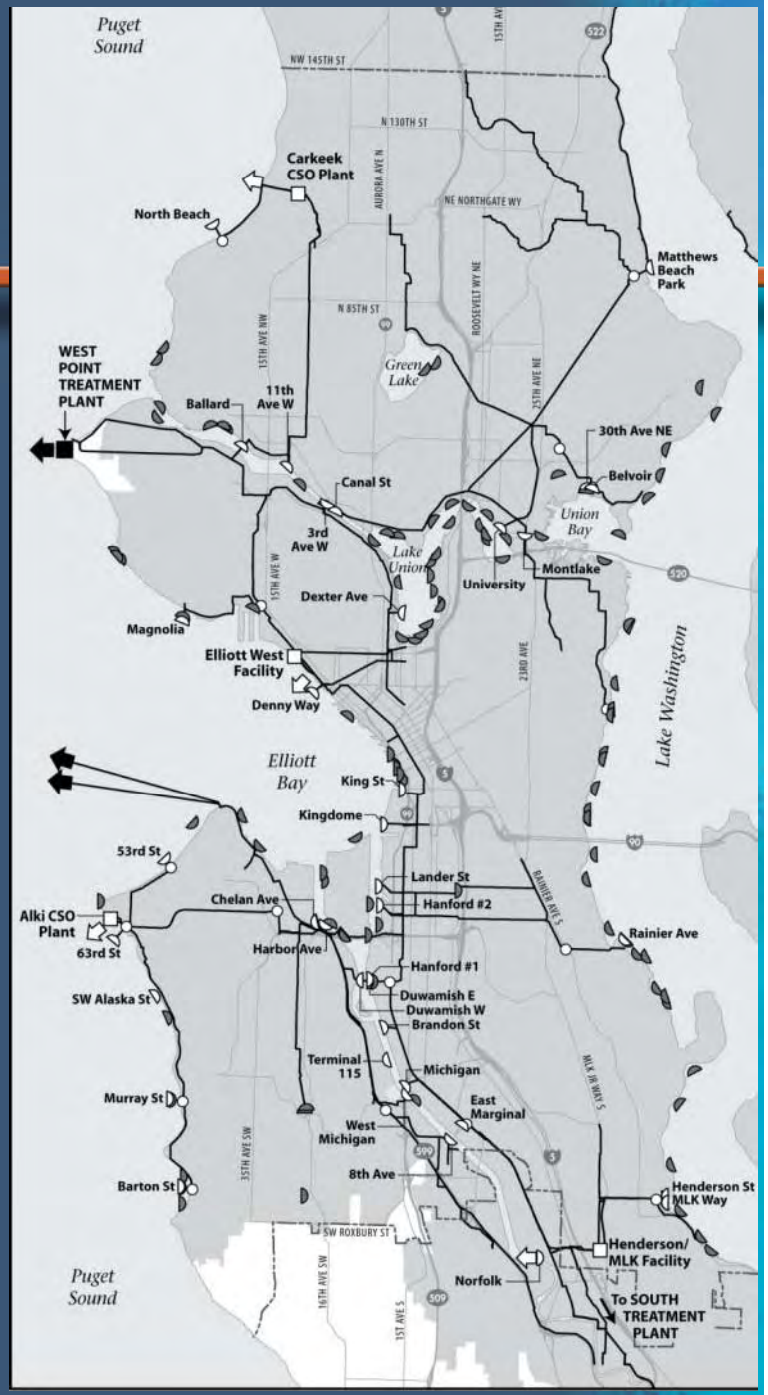
And Associated Firms

# Understanding the Murray Basin

- Provide additional information to describe the Murray basin collection and conveyance system
- Answer specific questions:
  - How were the control requirements developed?
  - How much additional volume/capacity is really needed to achieve control?
  - How do Barton basin flows affect the Murray basin requirements?

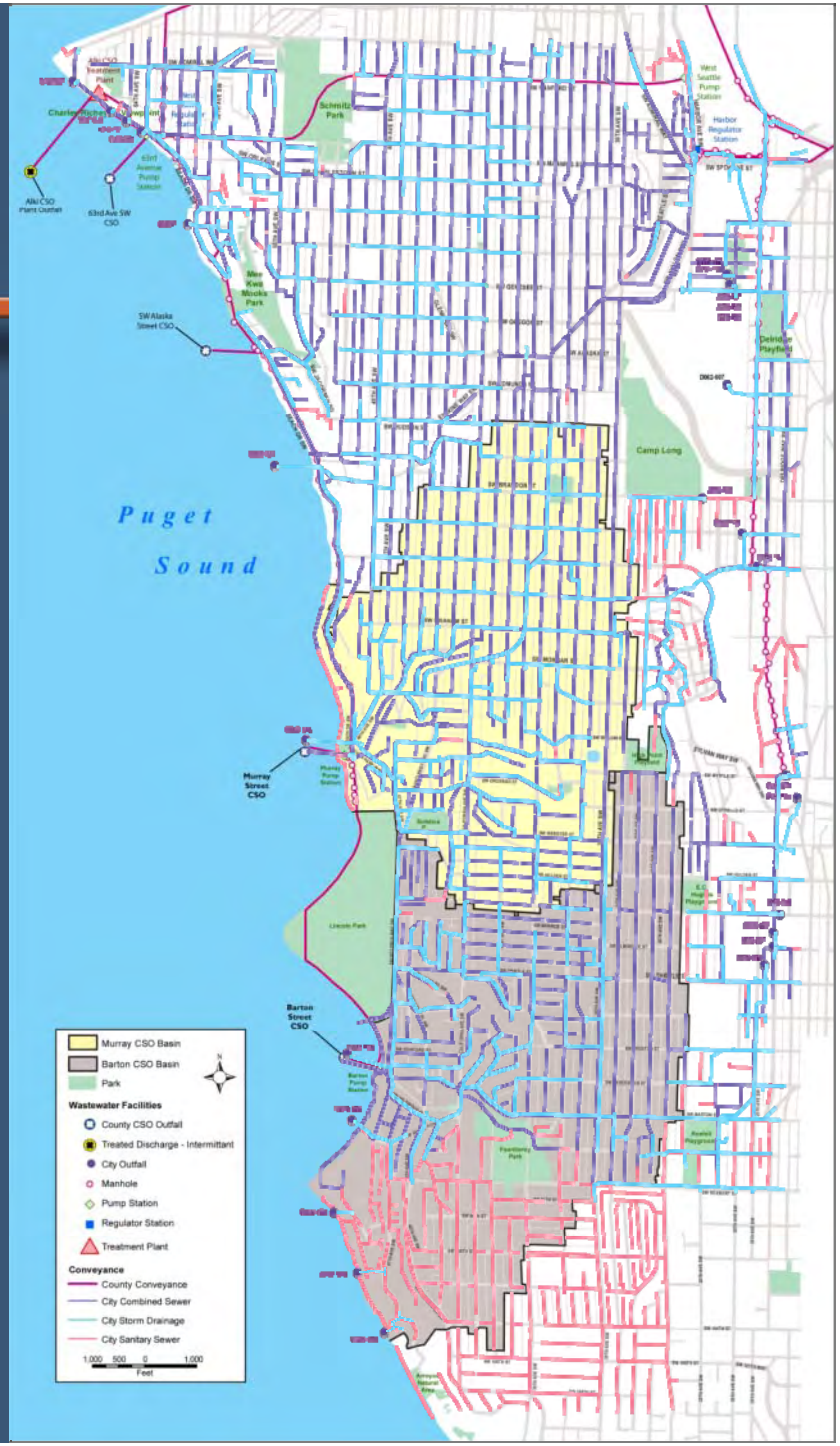
# Regional Conveyance System

- Barton and Murray basins are the “headwaters” of a regional conveyance system

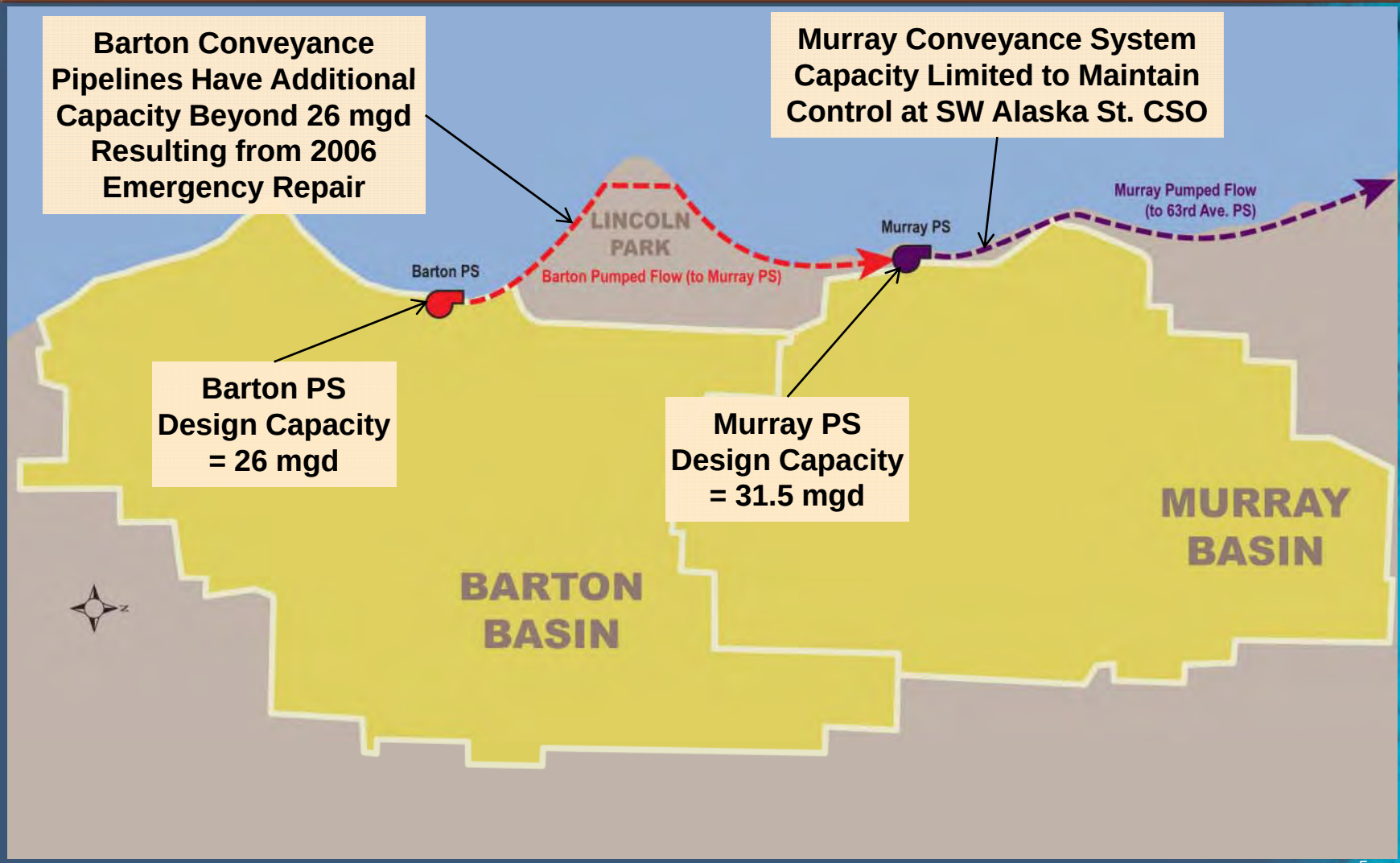


# King County and SPU CSO Systems

- Both King County and SPU operate CSO systems in Barton and Murray Basins
- SPU Basins 094 and 091 (Barton) and 090 (Murray) are each controlled



# Current Barton and Murray Conveyance System Capacity



# Barton Conveyance System

- Barton and Murray pump to 63rd Ave Pump Station; and ultimately to West Point Treatment Plant or Alki CSO Treatment Plant
- Barton PS design capacity is 26 MGD
- Barton conveyance system has higher capacity than pump station as a result of 2006 emergency repair
- Barton PS upgrade currently being designed will increase system capacity to 33 MGD

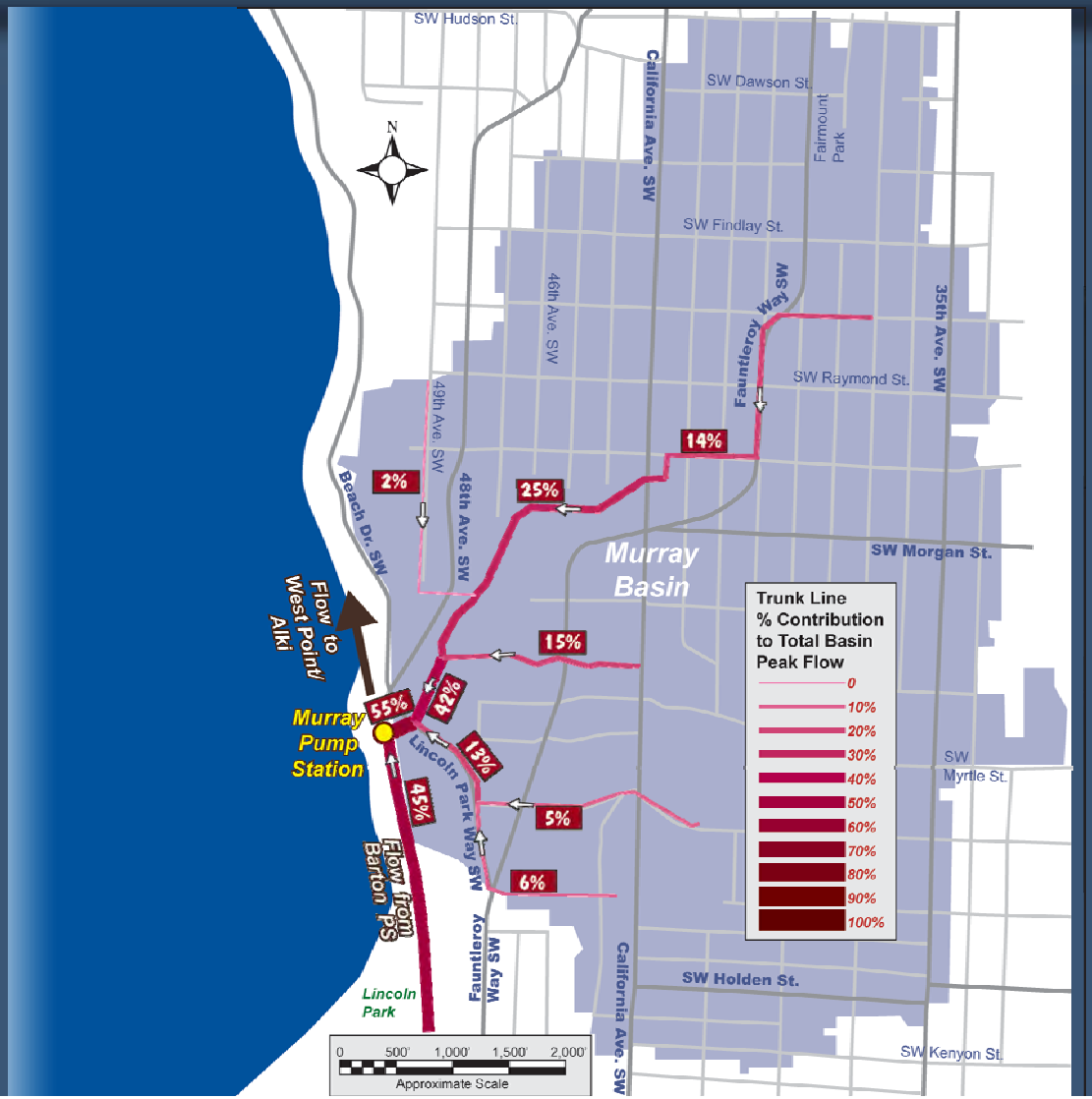
# Murray Conveyance System

- Murray PS capacity 31.5 MGD
- System capacity from Murray PS to 63rd Ave PS is restricted
- Any substantial flow increase through existing system would result in non-compliance at SW Alaska Street CSO
- Added pipelines would therefore be required to convey flows above 31.5 MGD north from Murray PS
- Murray PS requires an upgrade that is separate from the CSO requirements

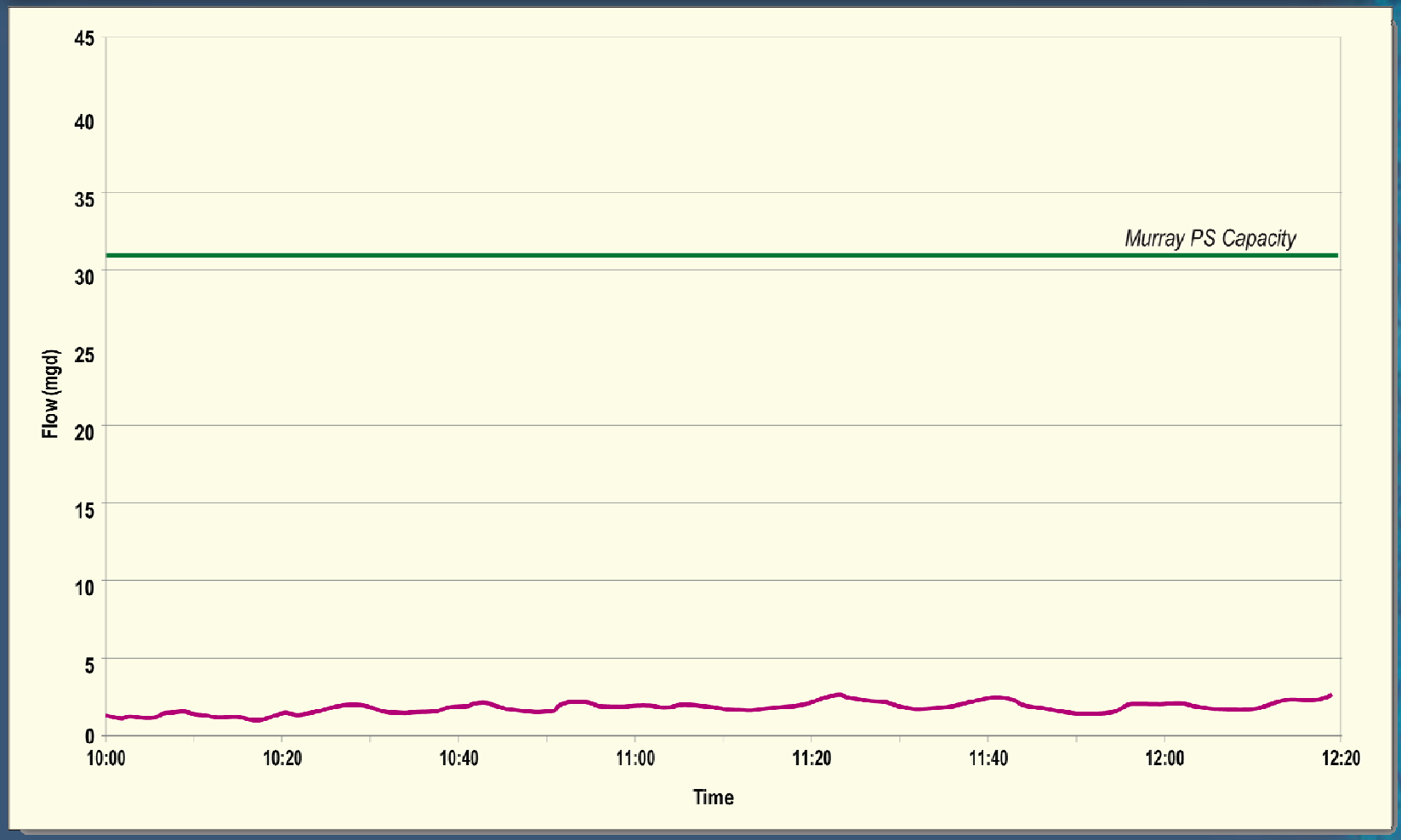
# Steps to Determine Control Requirements

- Measured existing flows
  - Barton & Murray PS flow meters
  - Collection system flow monitors
- Performed hydraulic/hydrologic analysis
- Calibrated the data to measured flows
- Used the analysis to predict flow response over a long-term rainfall record (30 years)
- Calculated storage/conveyance capacity needed for regulatory compliance

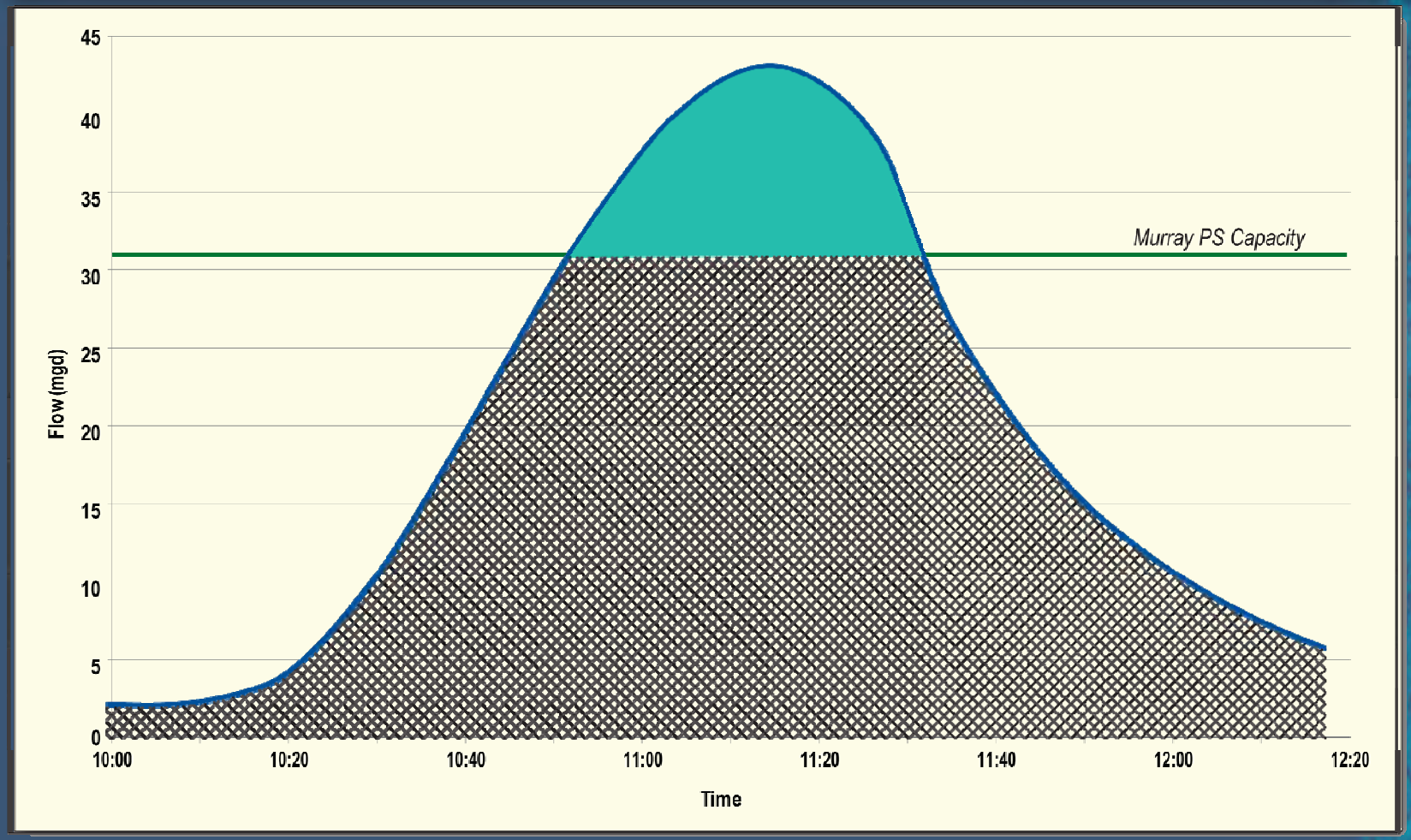
# Flow Measurements and Analysis Determined Basin Flow Distribution

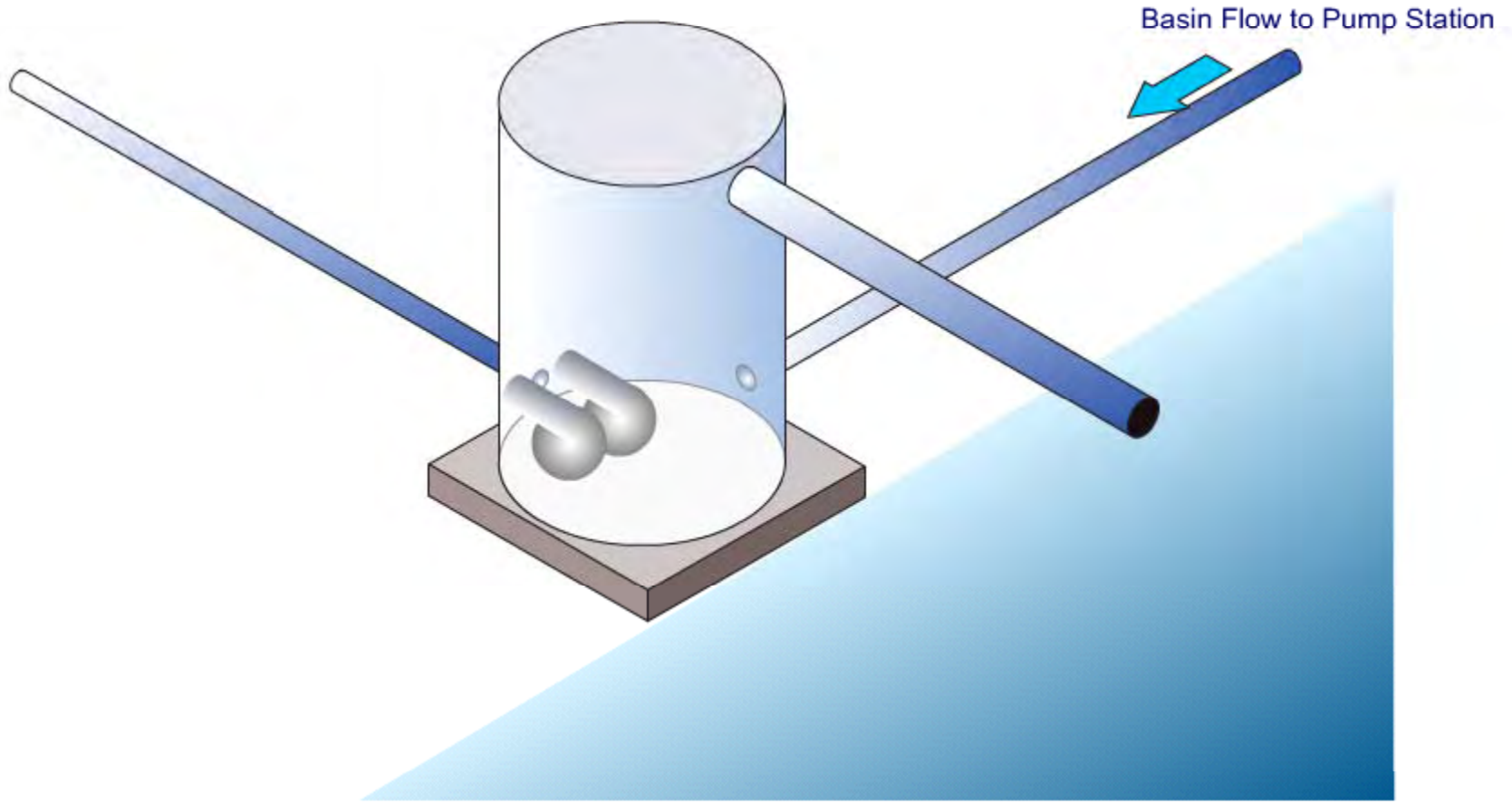


# “Typical” Murray Basin Dry Weather Hydrograph

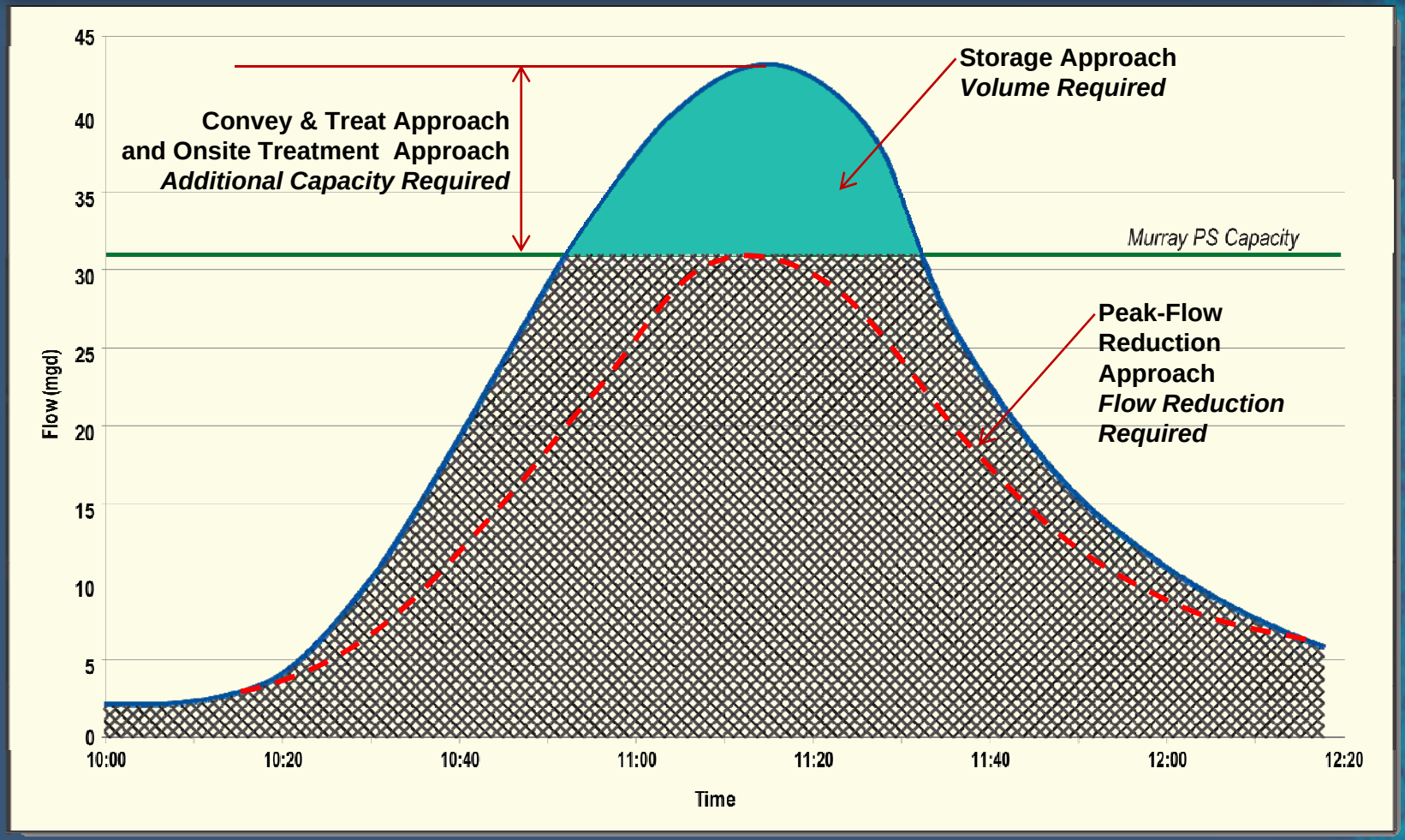


# Murray Basin Hydrograph During a CSO Event




Basin Flow to Pump Station

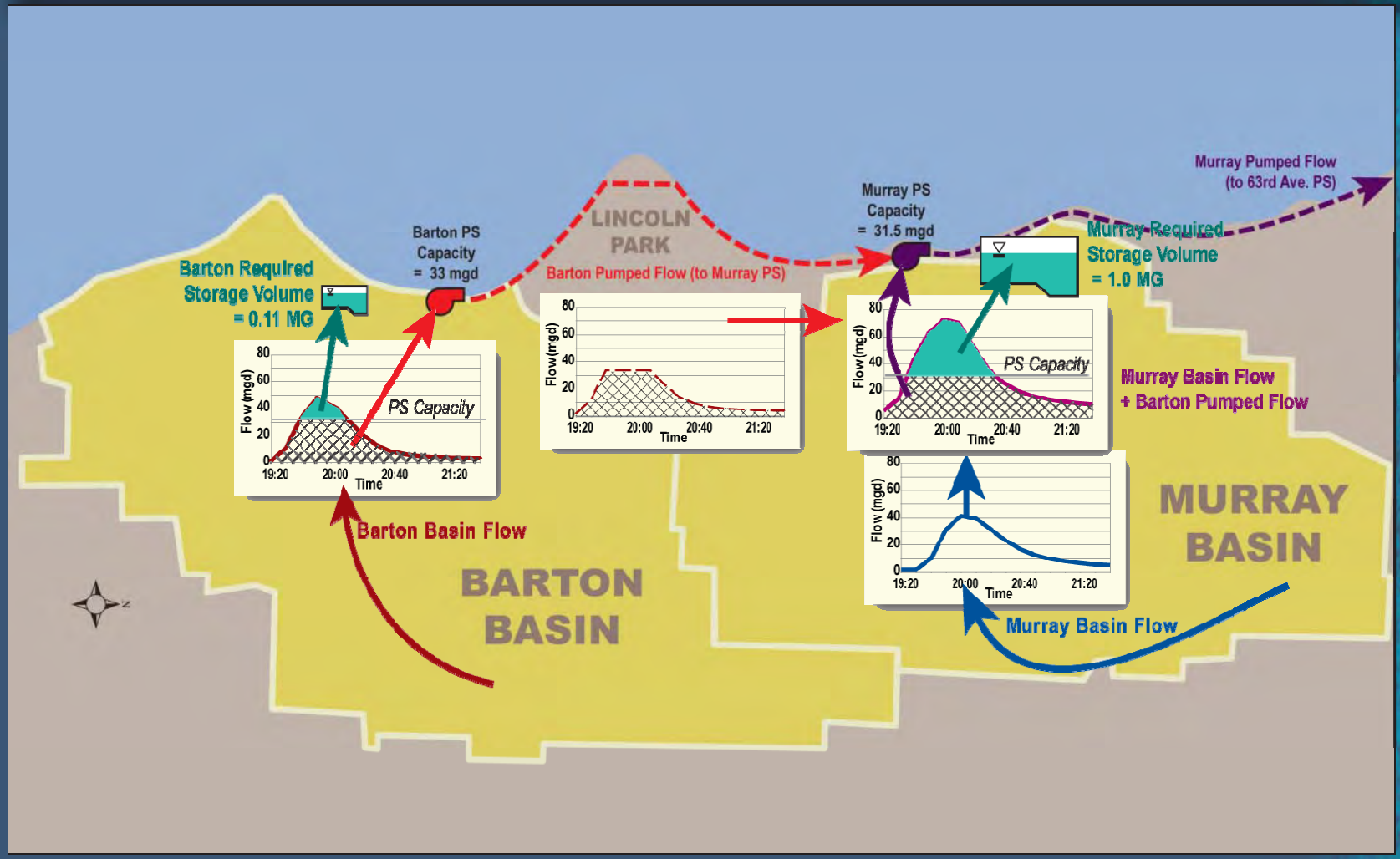
# CSO Control Needs Determined From Hydrograph



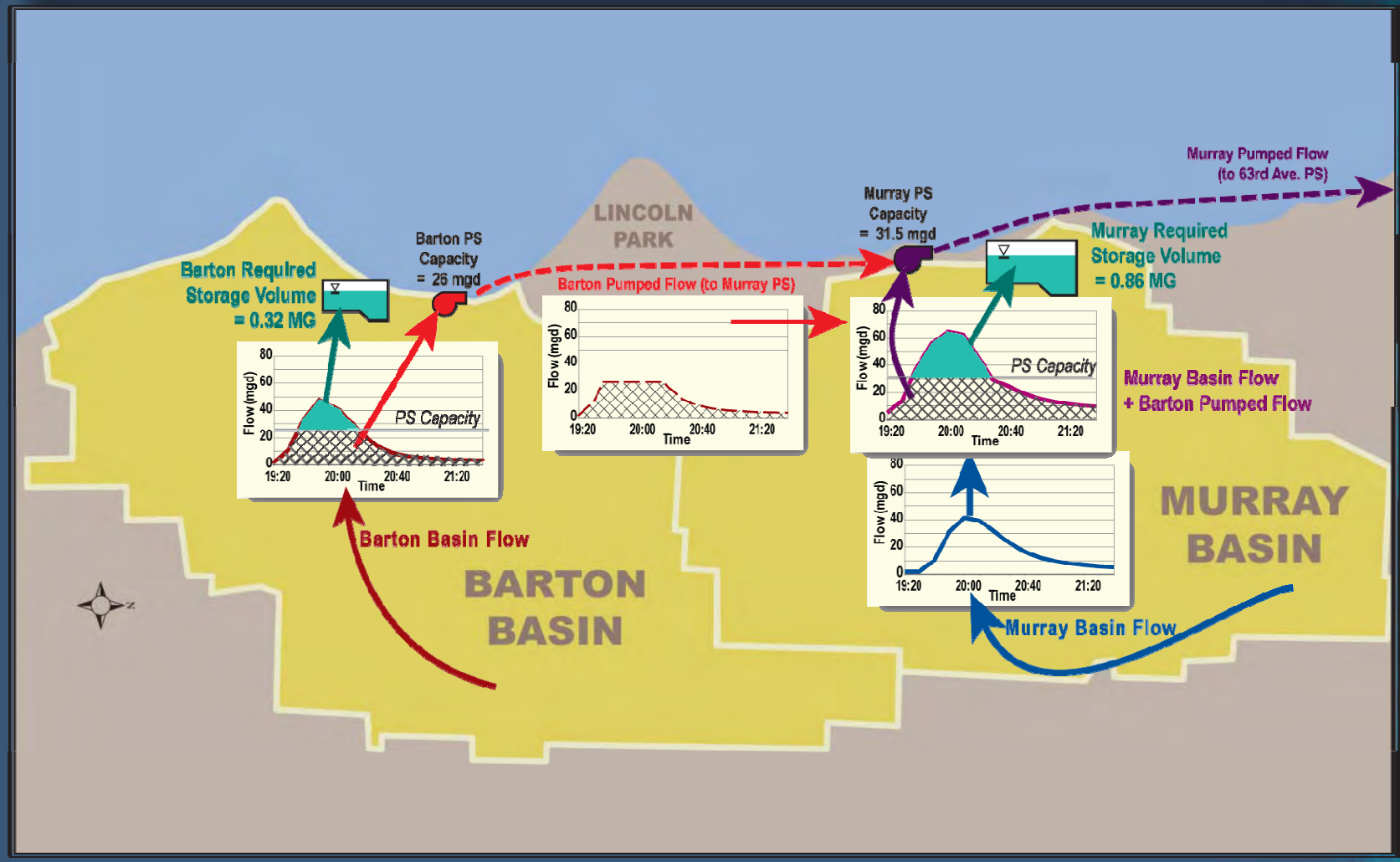
# Results of Analysis

- Murray CSO's
  - Average 5 events per year
  - Average 5 million gallons per year
- 1.0 MG storage is needed for CSO control
- 60 MGD of conveyance/treatment capacity required to eliminate storage
  - Existing Murray PS capacity is 31.5 MGD
  - Requires additional 28.5 MGD pump station capacity and second pipeline
- Analysis considered the effects of Barton flow on Murray basin requirements

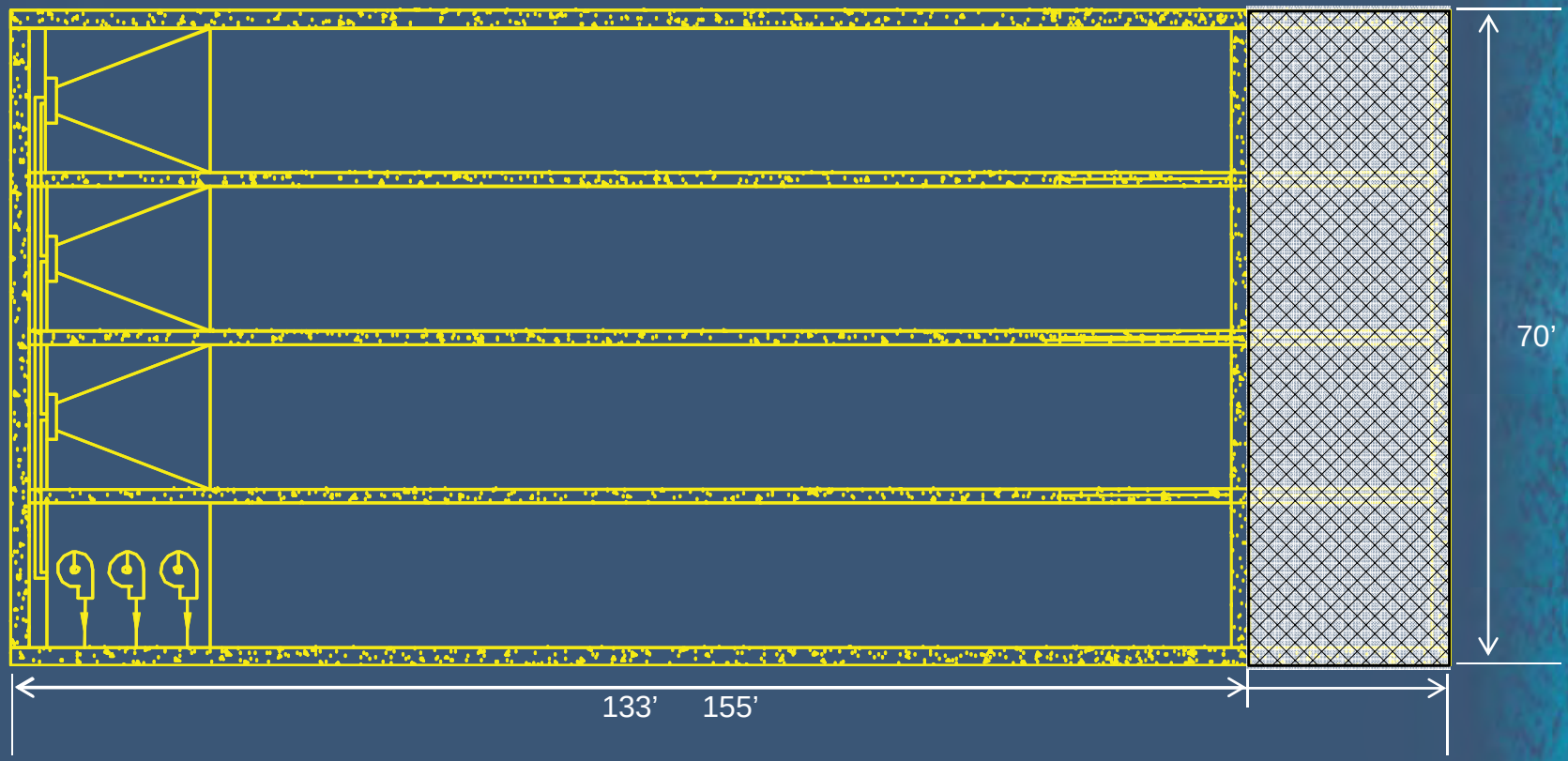
# Barton/Murray Flow Schematic – 33MGD Barton PS Capacity



# Barton/Murray Flow Schematic – 26MGD Barton PS Capacity



# Area Required for 1.0 MG Tank vs. 0.86 MG Tank

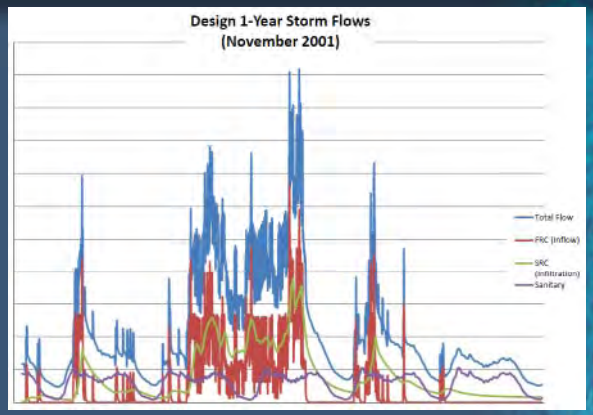


# Developing and Evaluating CSO Alternatives

- Provide additional information to describe the process of developing alternatives
- Answer specific questions:
  - What process was used to develop alternatives?
  - How would Green Stormwater Infrastructure (GSI) work in the basin?
  - What options and sites were considered in the basin?

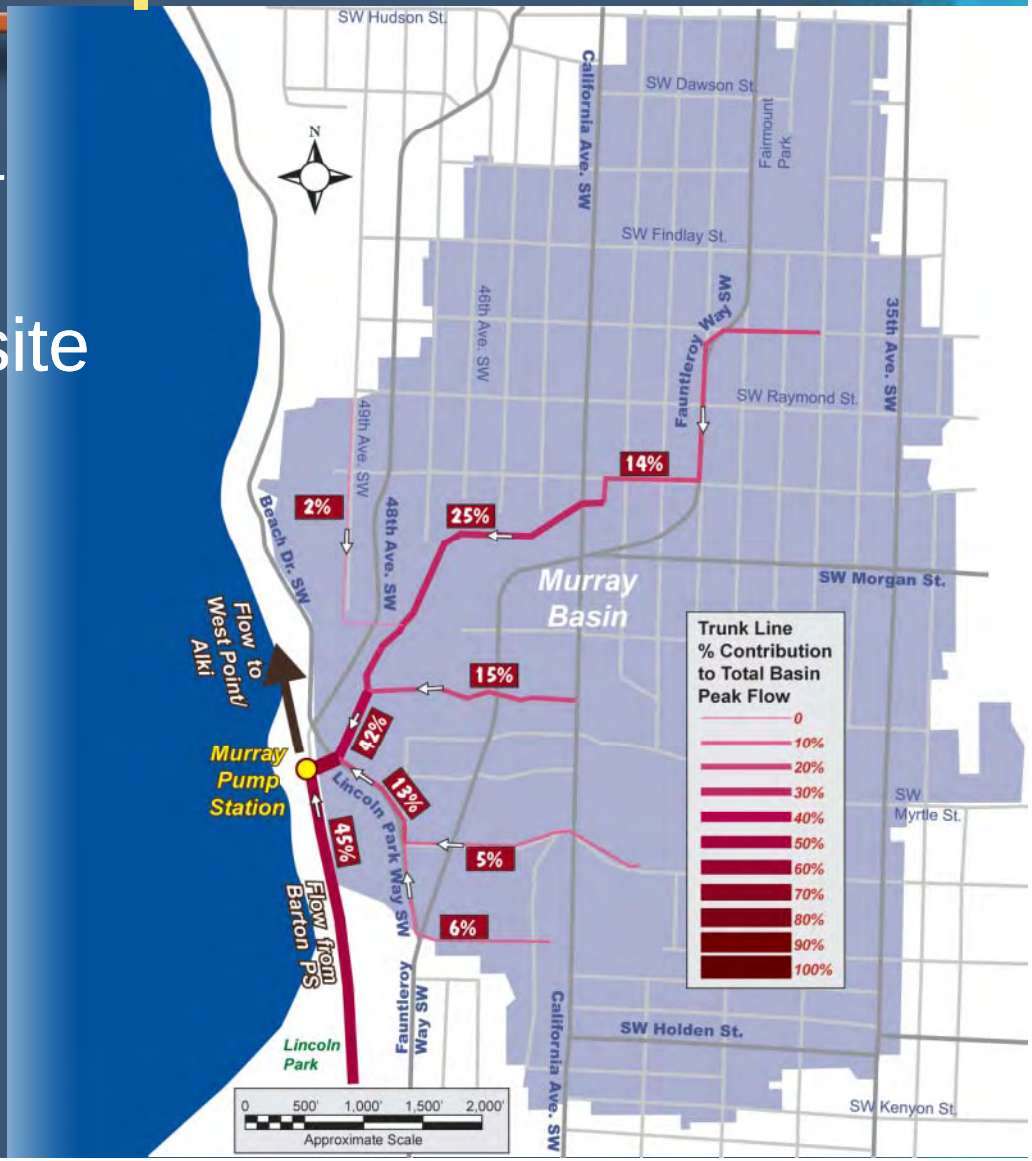
# Approaches Based on Technical Requirements and Feasibility

- Hydrologic/hydraulic analysis established control requirements
- Range of control approaches considered :
  - Storage
  - On-site Treatment
  - Conveyance and treatment
  - Peak flow reduction




# Alternatives Developed to Meet Basin Requirements

- What's required for a workable alternative:
  - Sufficient room to site and construct the facility?
  - Feasible to construct?
  - Will the alternative capture sufficient peak flow?

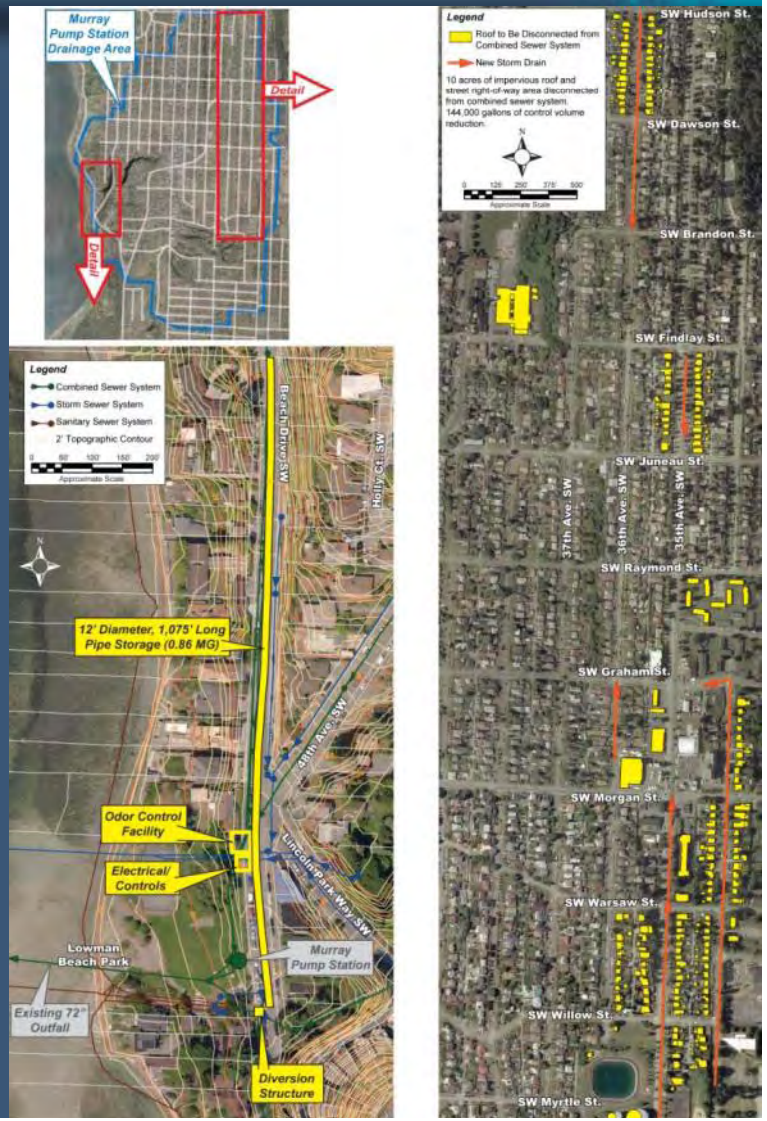


# Lower Murray Basin Characteristics

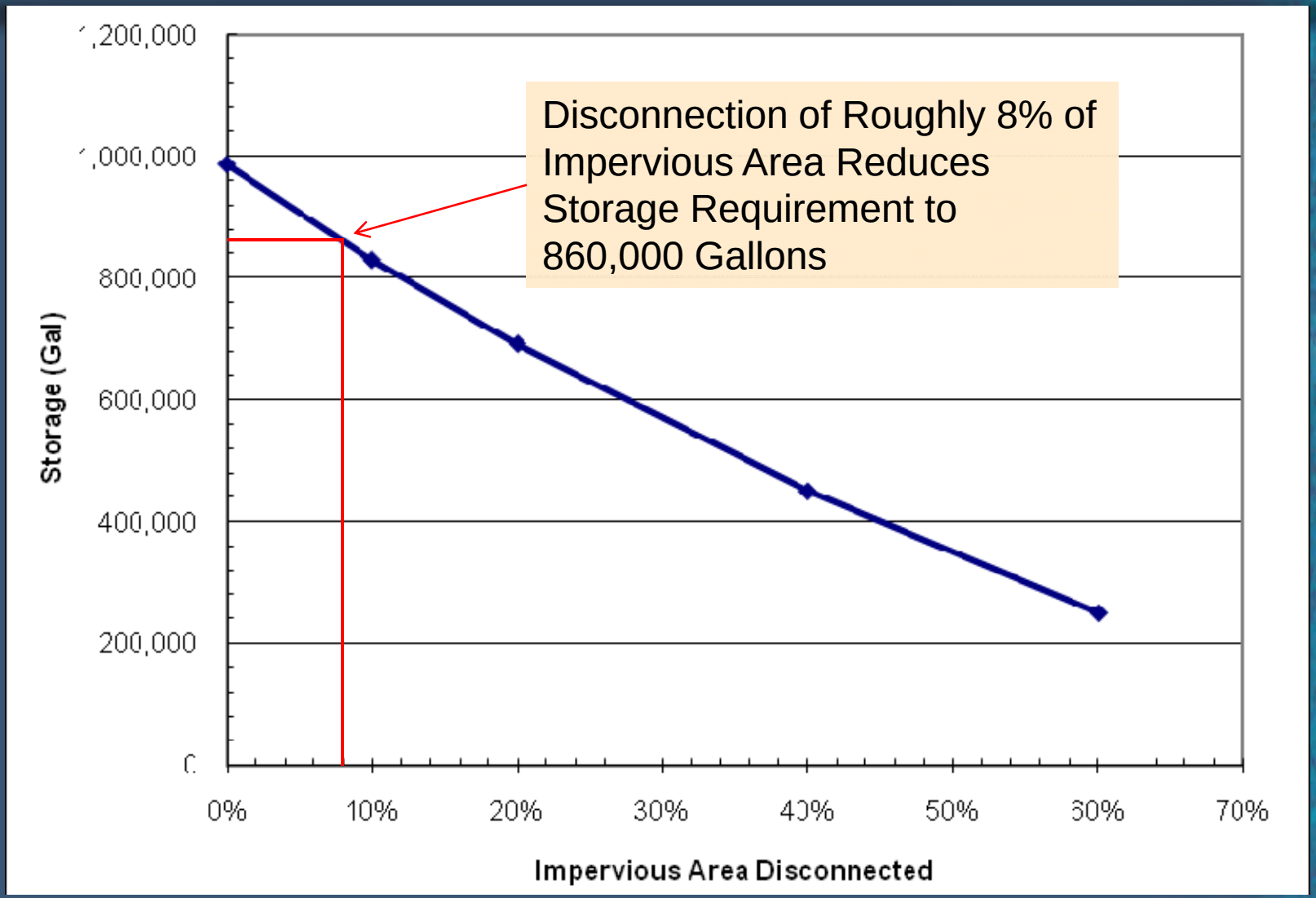
- Main regional CSO system pipes constructed adjacent to shoreline
- Steep basin topography presents challenges:
  - Need relatively flat ground for storage
  - Difficult to capture flow from Barton PS
- Little open space available in the vicinity of outfall

# 5A: Peak Flow Reduction Combined with Storage

- Characteristics:
  - Disconnect 10 acres of roof drains and street runoff in upper basin through traditional separation
  - Included re-routing of flows to new storm drain pipeline
  - Still required 0.86 MG of pipe storage along Beach Dr.



# Storage Reduction from Alternative 5A Impervious Area Disconnection



# Why Use Green Stormwater Infrastructure?

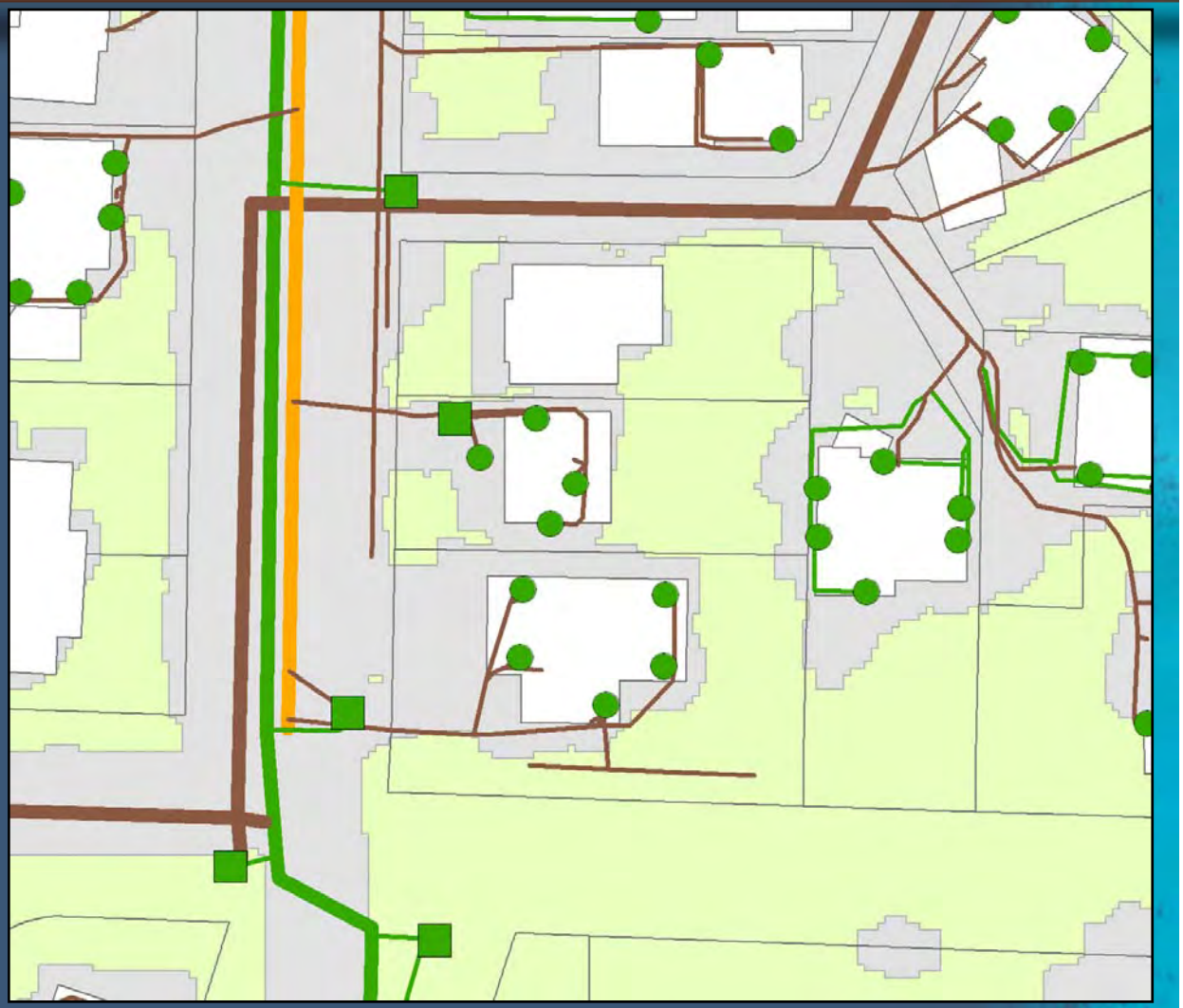
- Green Stormwater Infrastructure (GSI)
- Considerable challenges with using GSI
- King County and SPU worked together to integrate GSI into CSO planning
  - Reduce size of gray infrastructure project
  - Reduce costs of CSO program implementation
  - Reduce stormwater volume over time
  - Adapt to unknown future conditions

# GSI Evaluation

- Where does the flow come from and where is it going?

# Three Sources of Flow to the Combined Sewer System

- Roofs
- Impervious areas
- Pervious areas



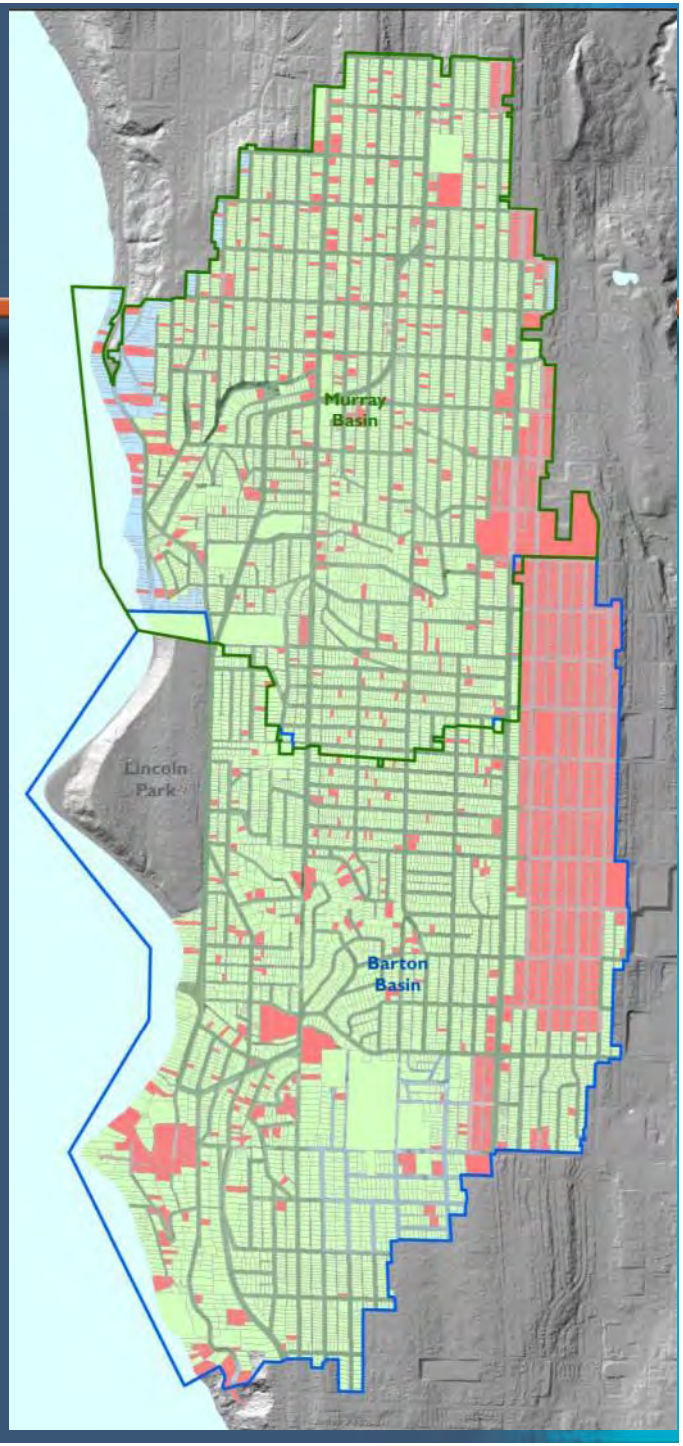
# Field Verification

# GSI Spatial Analysis

- Identify five GSI techniques
  - Ecoroofs/Green Roofs
  - Roof Disconnection
  - Street Trees
  - Bioretention (i.e. Rain Gardens)
  - Permeable Pavement
- Use a set of criteria to identify suitable locations

# Results of Analysis

- Maps of connected areas
- Estimation of amount of impervious and pervious areas connected to the combined sewer system
- Feasible area for green techniques



# GSI Project in Barton

- Identified Barton basin as having highest feasibility for most green techniques
- Identified large area of streets connected to combined sewer system
- Opportunity to explore a project similar to SPU's Ballard Roadside Rain Gardens project
- Allow SPU and King County to evaluate design, construction and performance of GSI in combined sewer basins

# Examples of Streets with GSI

Seattle

Port Townsend

# Examples of Streets with GSI

Seattle

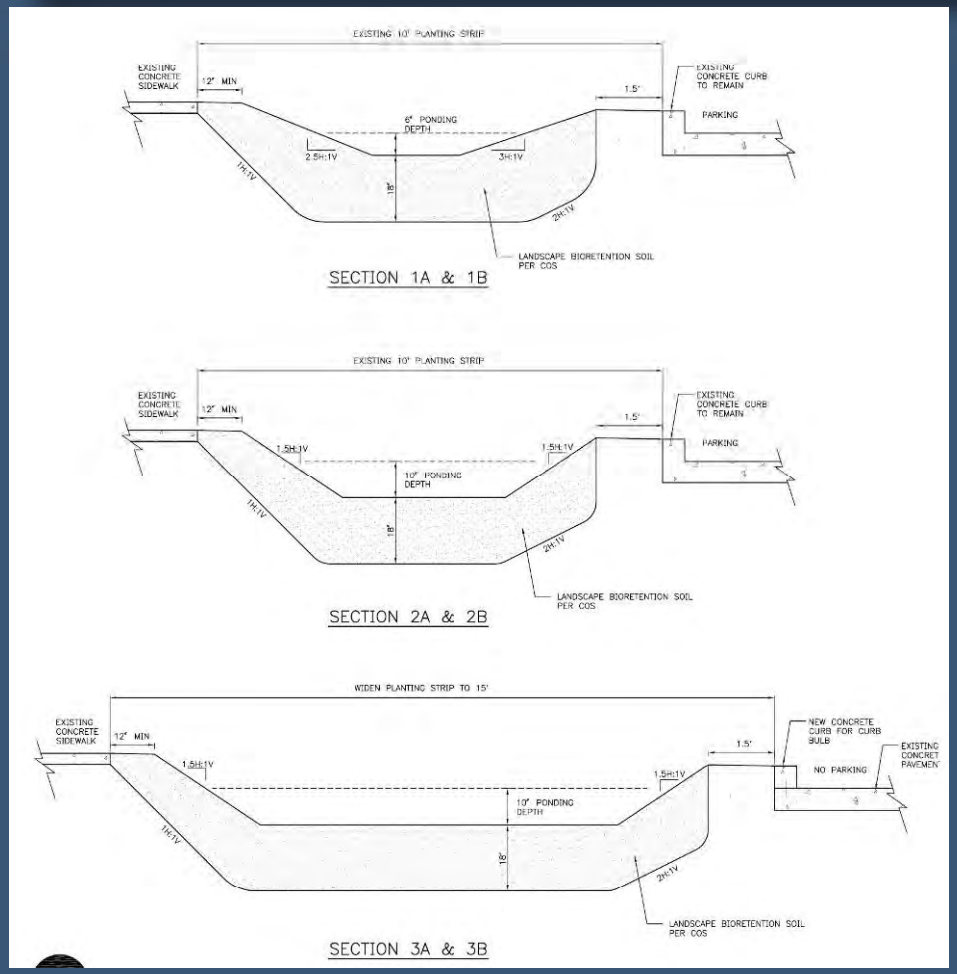
Portland

# Changes to Streetscape with GSI

- Parking
- Walkability
- Landscape Treatment
- Private Property
- Maintenance

# Concept Street with GSI Before and After

# Barton Subbasin 416
# Street Cross-Section Options



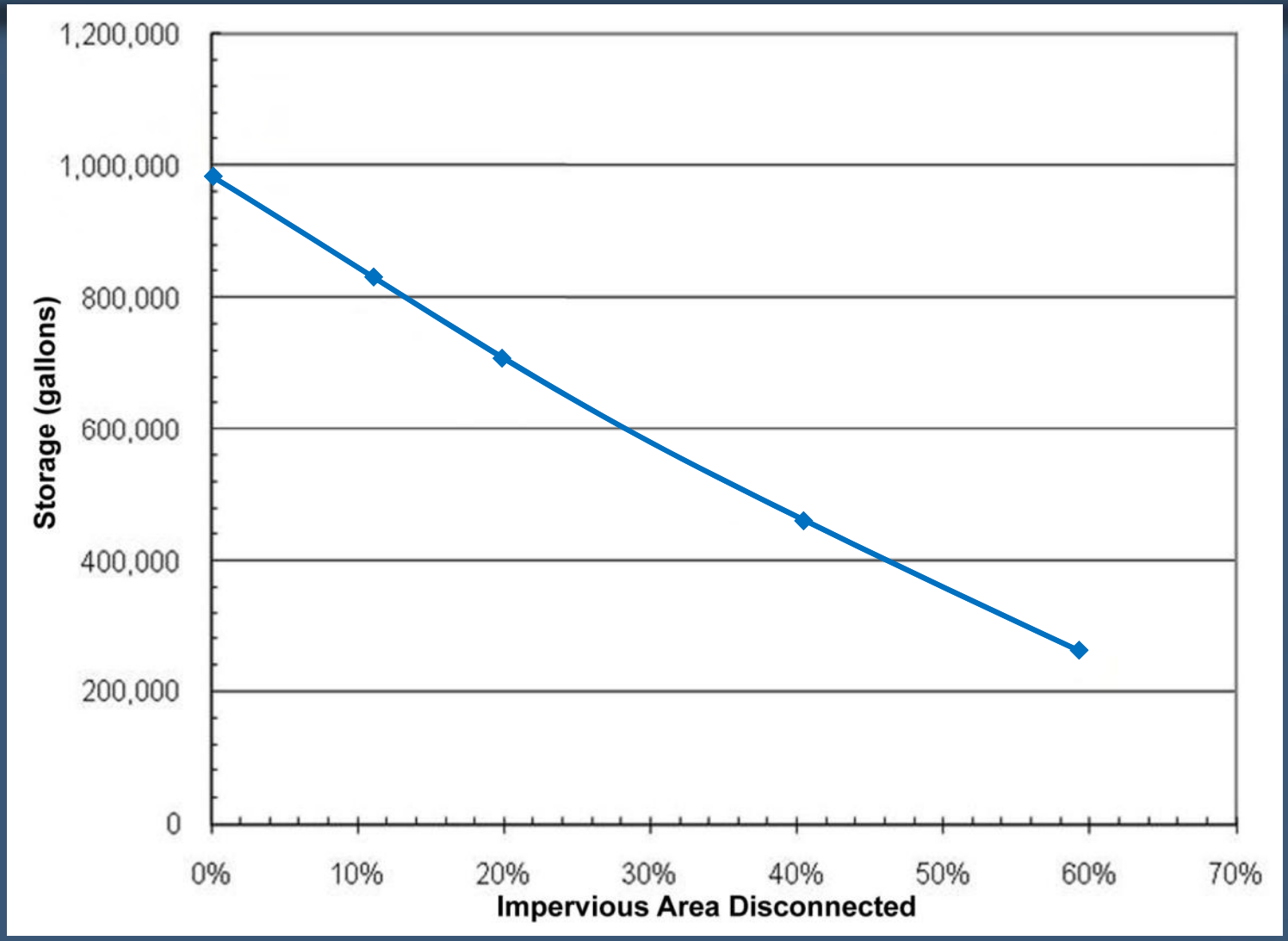

# Components of Barton GSI Alternative

- 66+/- modified blocks with green stormwater infrastructure
- Private parcel adaptations through SPU's Rainwise Program and other King County Programs
  - Cisterns
  - Bioretention – (i.e. rain gardens)
  - Permeable pavements
  - Infiltration
  - Vegetation

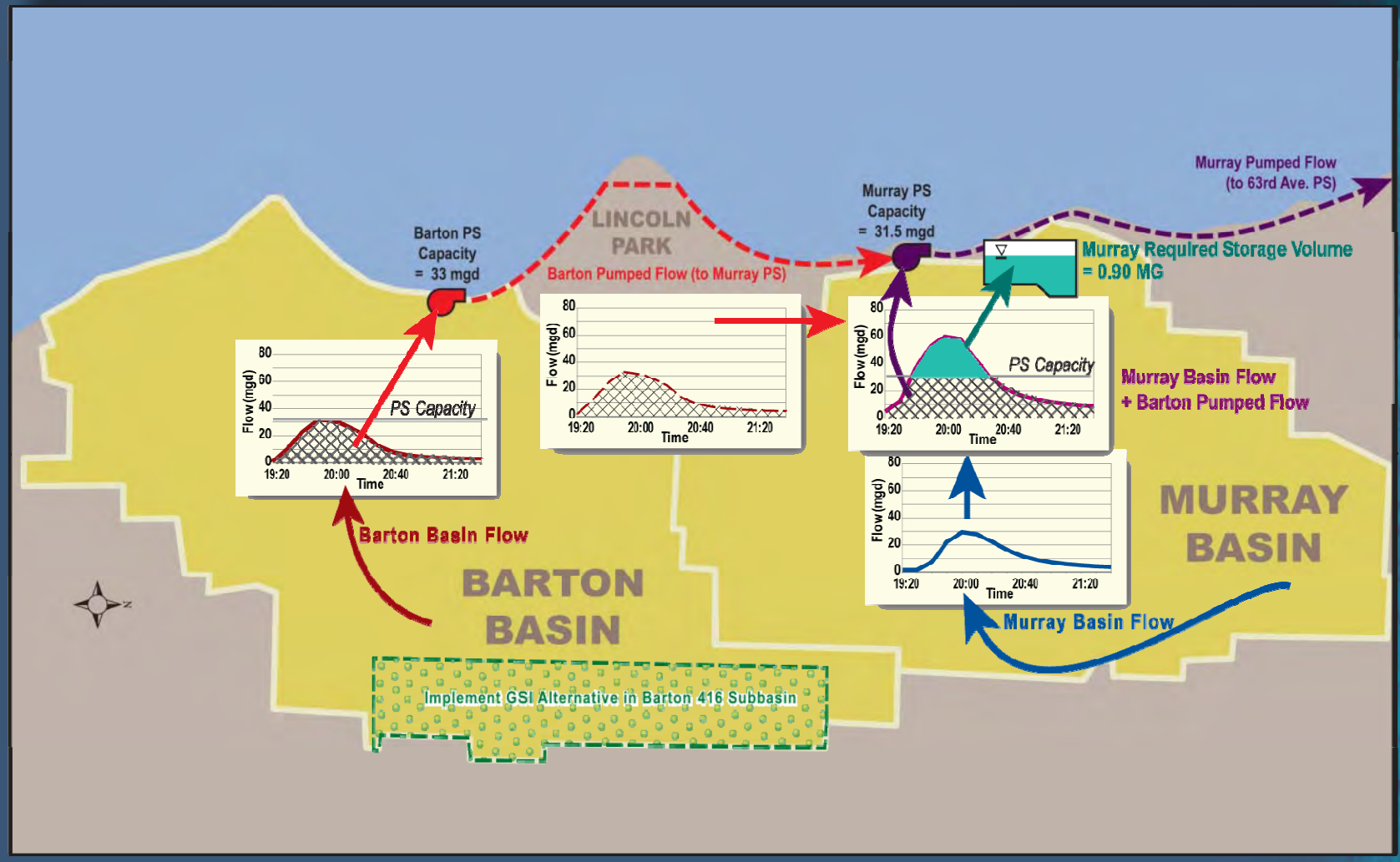
# Goal of Barton GSI Alternative

- Goal of alternative is to eliminate the 110,000 gallon storage requirement in Barton basin

# Murray Storage Reduction from GSI Implementation in Barton

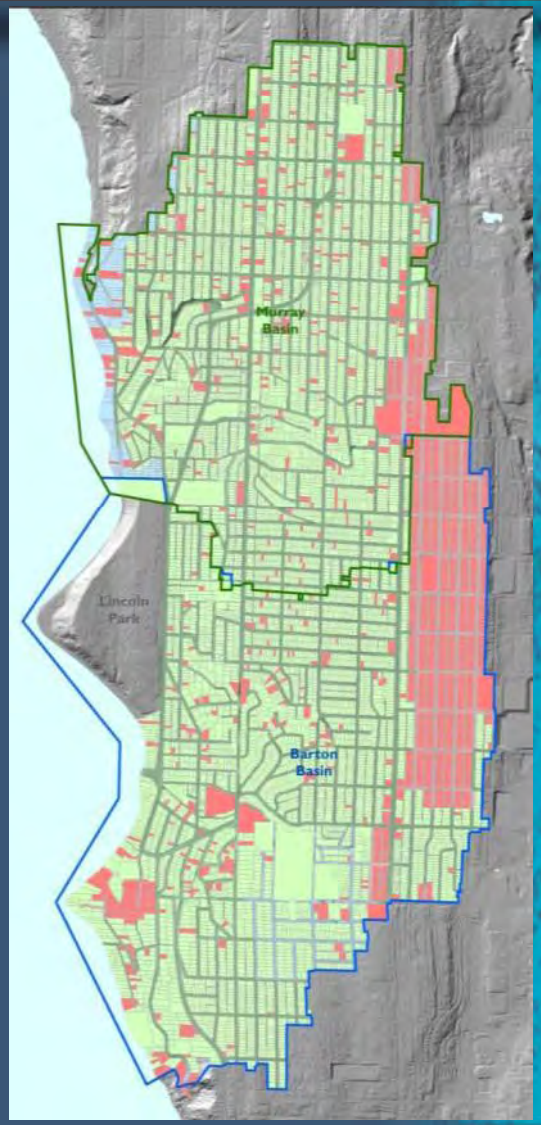


# How Implementation of Barton GSI Affects Murray Requirements



# Initial GSI Analysis In Murray Basin

- Initially investigated GSI following development of Murray Alternative 5A
- Initial estimates concentrated on disconnection of residential roof runoff through Residential RainWise program
- Initially estimated maximum storage reduction of 148,000 gallons in basin
  - Considered properties away from steep slopes
  - Required participation of 435 parcels
  - Assumed 40% participation of properties

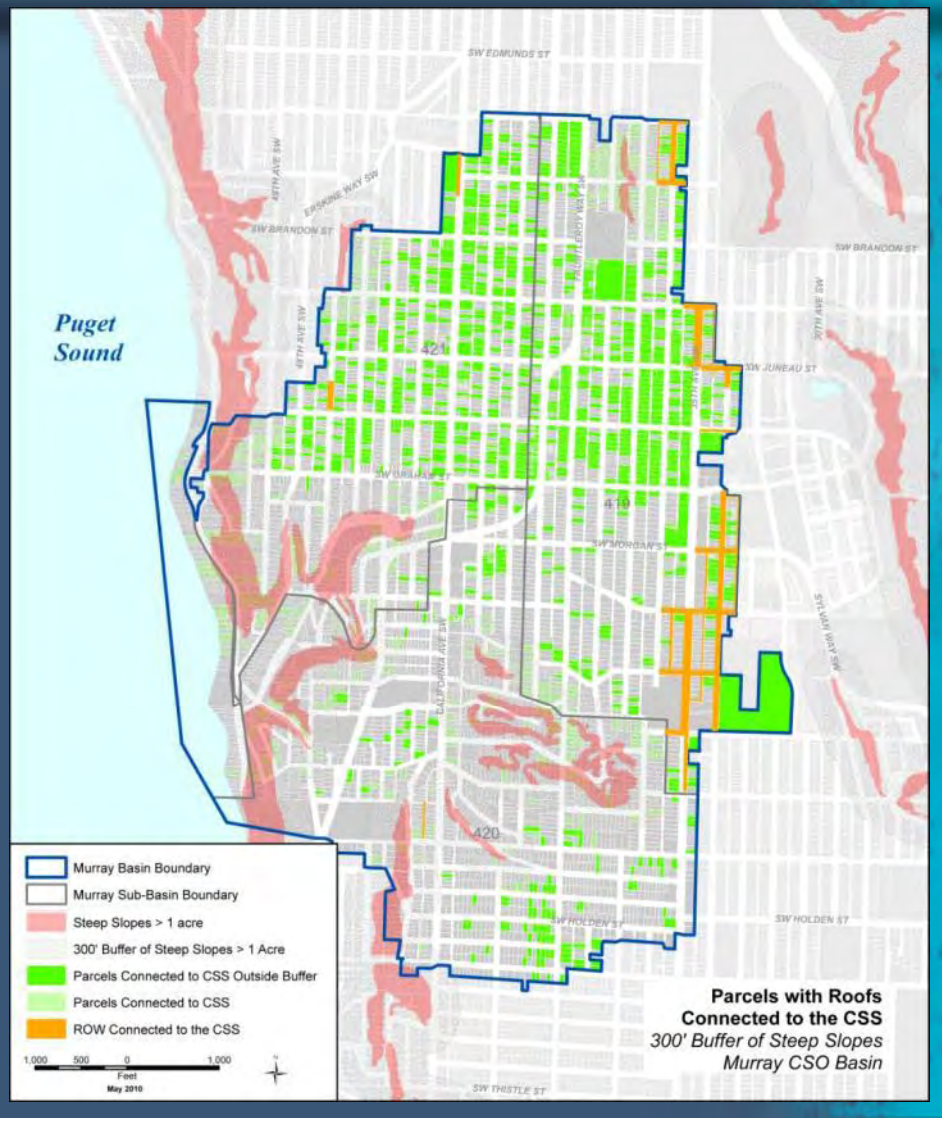


# Green Stormwater Infrastructure (GSI) in Murray

- Re-evaluation considered the following:
  - Voluntary GSI on private property
    - Rain gardens away from steep slopes
    - Cisterns within steep slope buffers
    - Assumed 50% participation
  - Disconnection of non-residential areas
    - Assumed 50% participation
  - Disconnection of available street right-of-way

# GIS Evaluation for Green Stormwater Infrastructure in Murray

- Connected areas established through geographic information system evaluation



# Impervious Areas Connected to Combined Sewer System in Murray

| Source | Acres |
|---|---|
| Residential Roof Area | 48 |
| Residential Impervious | 16 |
| Non-Residential Roof | 16 |
| Non-Residential Impervious | 20 |
| CSS ROW (Streets) | 11 |
| TOTAL | 111 |

# How Far Can We Go With GSI in the Murray Basin

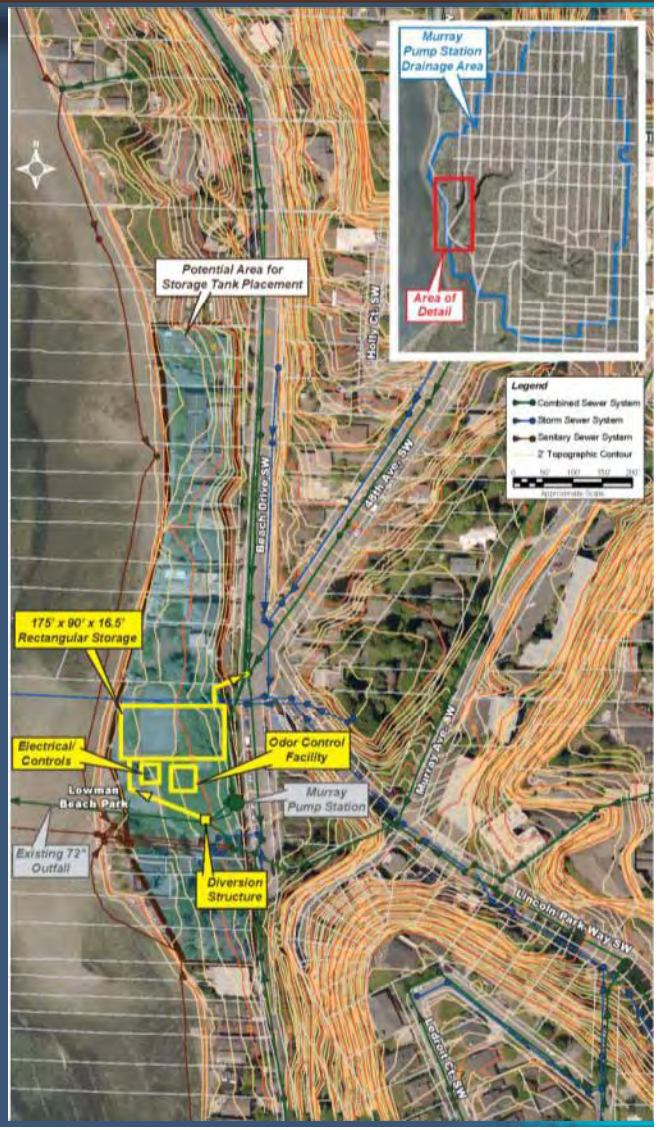
- Possible to reduce storage volume
- Challenges
  - Unproven criteria and assumptions
  - Implementation requires voluntary participation
  - Enough storage to contain peak CSO
  - Buy-in from regulators

# What Other Options Were Considered?

- 1A: Bottom of Basin Storage
- 1B: Near Bottom of Basin Storage (Circular Tank)
- 1C: Pipeline Storage (Open Cut Distributed Storage)
- 1D: Pipeline Storage (Tunneled Bottom of Basin)
- 1E: Upper Basin Storage
- 1F: Bottom of Basin Storage (Tank and Pipeline)
- 2A: Convey/Treat
- 3A: On-site Treatment
- 5A: Combined Storage and Peak Flow Reduction

# 1A: Tank Storage at Bottom of Basin

- Characteristics:
  - 1 MG storage tank sited in vicinity of Murray PS
  - Low operational complexity



# 1B: Circular Storage in Vicinity of Murray Ave SW and Murray Ave SW

- Characteristics:
  - 1 MG tank near bottom of basin
  - Considers City of Seattle site north of Lincoln Parkway SW
  - City site contains Pelly Creek and steep slopes
  - Additional small wet weather pump station needed near existing Murray PS

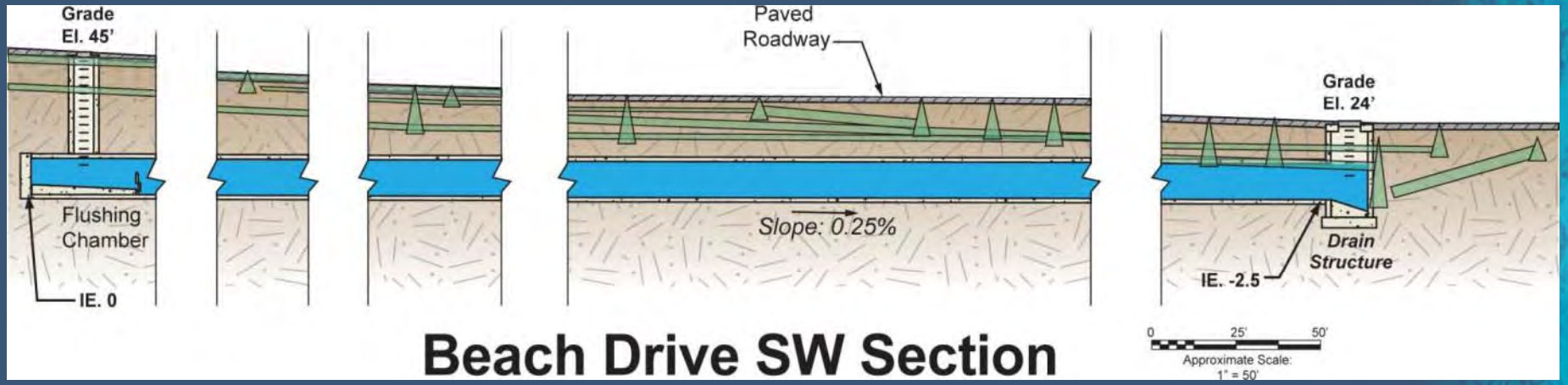
# City Owned Property North Side of Lincoln Parkway SW

# 1C: Distributed Storage Along Beach Dr and Murray Ave SW

- Characteristics:
  - 12-ft diameter pipe storage in two locations
  - Alternative was developed with open cut pipeline installation in mind
  - Structures required on each end of pipelines
  - Higher level of operational complexity with multiple storage locations
  - Additional refinement indicating open cut installation does not appear feasible along Beach Dr

# Beach Drive Looking North

# Storage Pipeline Profile on Beach Drive



# 1D: Tunneled Pipe Storage at Bottom of Basin

- Characteristics:
  - 1 MG storage in single pipeline
  - Portals and structures required on each end tunnel
  - Low operational complexity since near Murray PS

# 1E: Storage in Upper Basin

- Characteristics:
  - More flexibility to site storage
  - Second large wet weather pump station required at bottom of basin
  - New conveyance pipeline between pump station and storage

# 1F: Combined Pipe and Tank Storage at Bottom of Basin

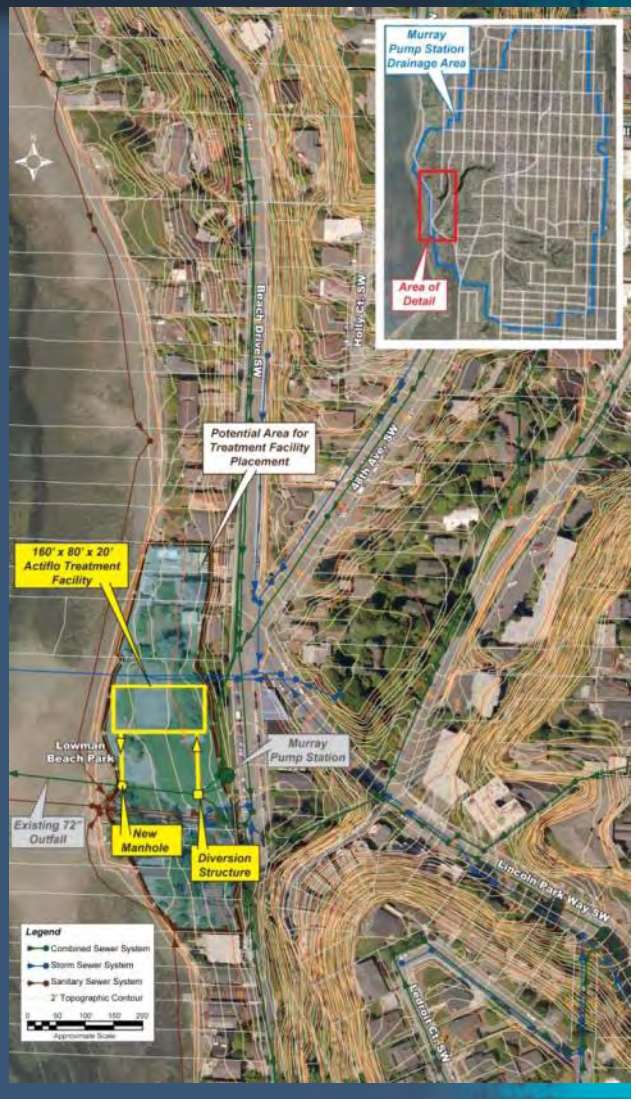
- Characteristics:
  - Maximize tank storage volume
  - Supplement with pipe storage to achieve 1 MG
  - Low operational complexity since near Murray PS

# 2A: Convey and Treat at Alki

- Characteristics:
  - Conveys peak flows out of the basin
  - Second large wet weather pump station needed at bottom of basin
  - Roughly 2-1/2 miles of new conveyance pipeline needed along Beach Dr
  - Alki CSO treatment plant upgrades required including new outfall

# 3A: On-site Treatment at Bottom of Basin

- Characteristics:
  - Wet weather treatment plant located at bottom of basin
  - 28.5 mgd plant capacity required
  - Low operational complexity to get peak flows to plant
  - High operational complexity to operate new plant



# Other Alternatives Considered

- Combined Barton/Murray tunnel storage considered under Lincoln Park
- Characteristics:
  - Requires construction adjacent to and through steep unstable slopes
  - Tunnel staging in Lowman Beach Park and Lincoln Park
  - Long alignment
  - Would require new wet weather pump station at Barton
  - Force main required along SW Fauntleroy

# Lincoln Park Tunnel Profile