Subsurface Desalination Intake & Potable Reuse Feasibility Studies

TAP Workshop #1

City of Santa Barbara, California

August 5, 2015

Engineers...Working Wonders With Water®

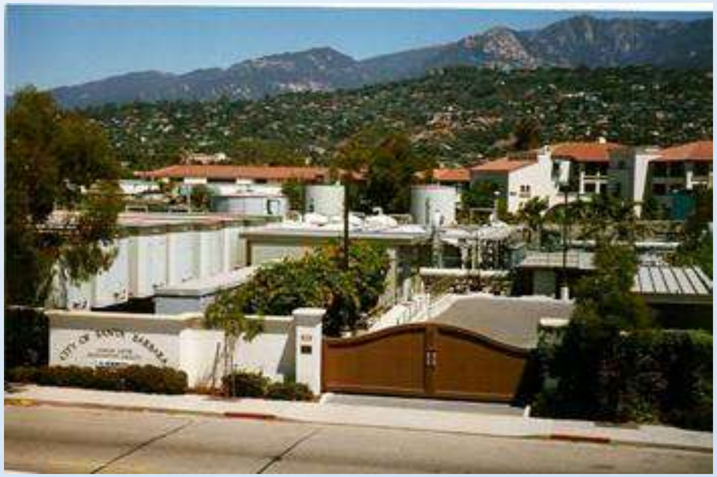
Agenda

- Project History
- Feasibility Study Background & Objectives
- Feasibility Study Scope
  - Subsurface Intake Study
    - Basis of Design
    - Feasibility Criteria & Fatal Flaws
  - Potable Reuse Study
    - Basis of Design
    - Feasibility Criteria & Fatal Flaws
  - Implementation Schedule, Cost Estimate & Feasibility Analysis
  - Technical Advisory Process

Project History

Charles Meyer Desalination Plant

- Constructed as emergency supply
  - Capacity @ 7,500 AFY (6.7 mgd); 10,000 AFY (8.9 mgd) expansion
- Operated March - June 1992
  - Delivered ~419 AF of desalinated water
- Long-term standby mode – 1994
- Permanent facility
  - 1991 - City voters overwhelmingly approve adding desalination as a permanent facility
  - 1994 - Long-Term Water Supply Plan
  - 1996 - Permanent facility permits
  - 2010 and 2011 - City Council reaffirms desalination as a permanent part of City’s water supply



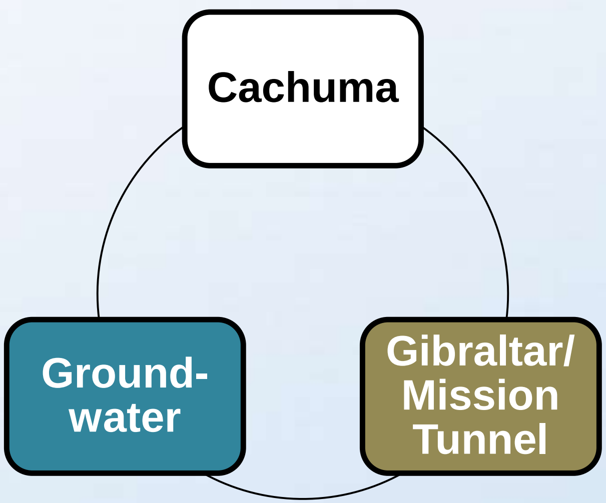
Charles Meyer Desalination Plant

Overview of desalination facilities

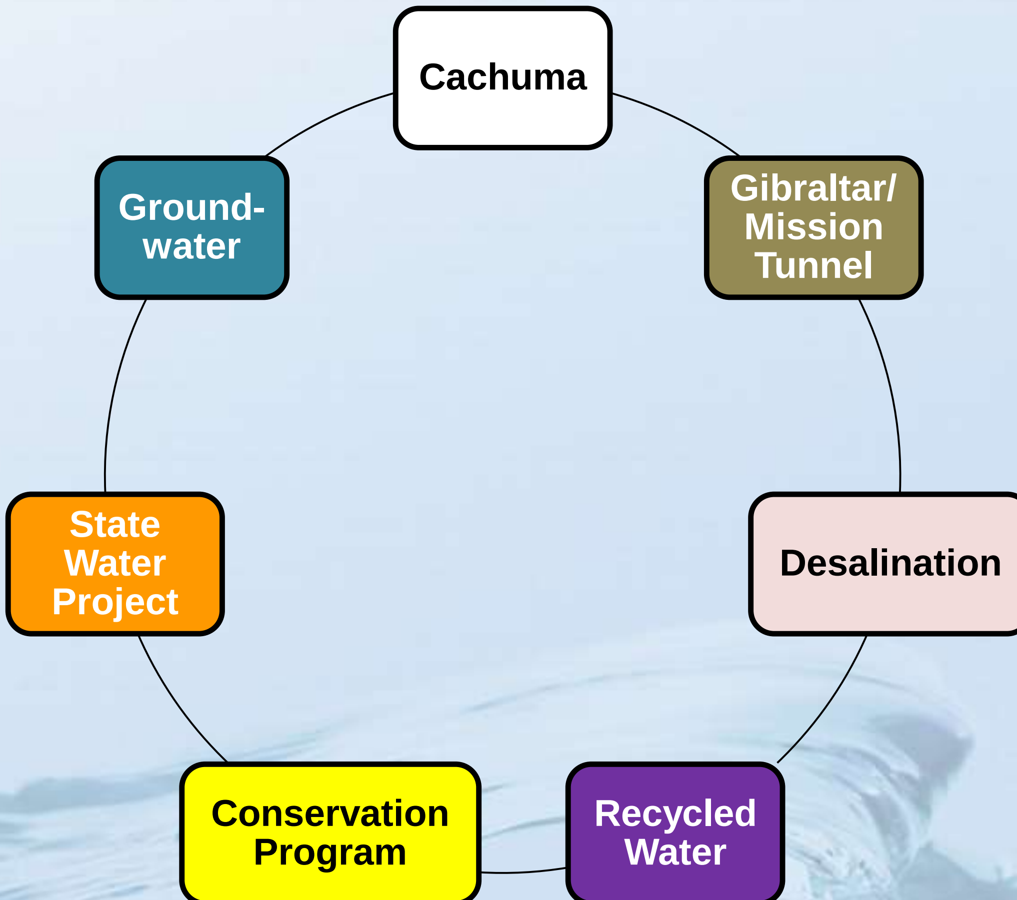
- Intake: 2,500 feet off shore
- Pump Station/Chemical Area: 420 Quinientos Street
- Desalination Plant: 525 Yanonali Street
- Outfall: 8,720 feet off shore
  (shared with El Estero WWTP)

The City has diversified their water supply portfolio to improve reliability

1980s

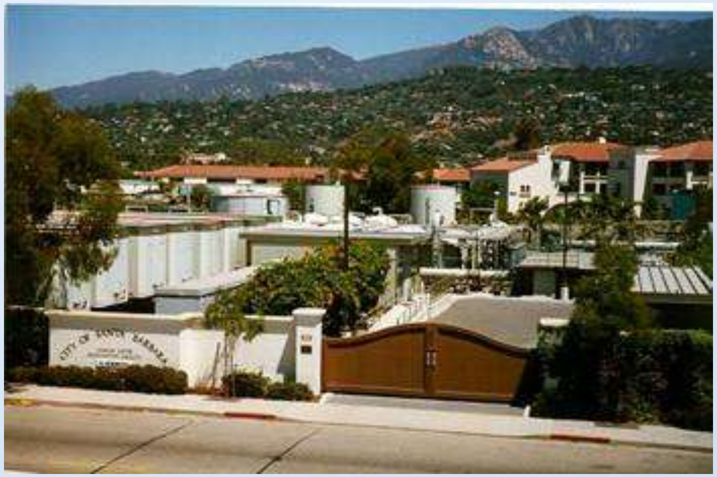


Current



Drought supply as called for by the Long-Term Water Supply Plan

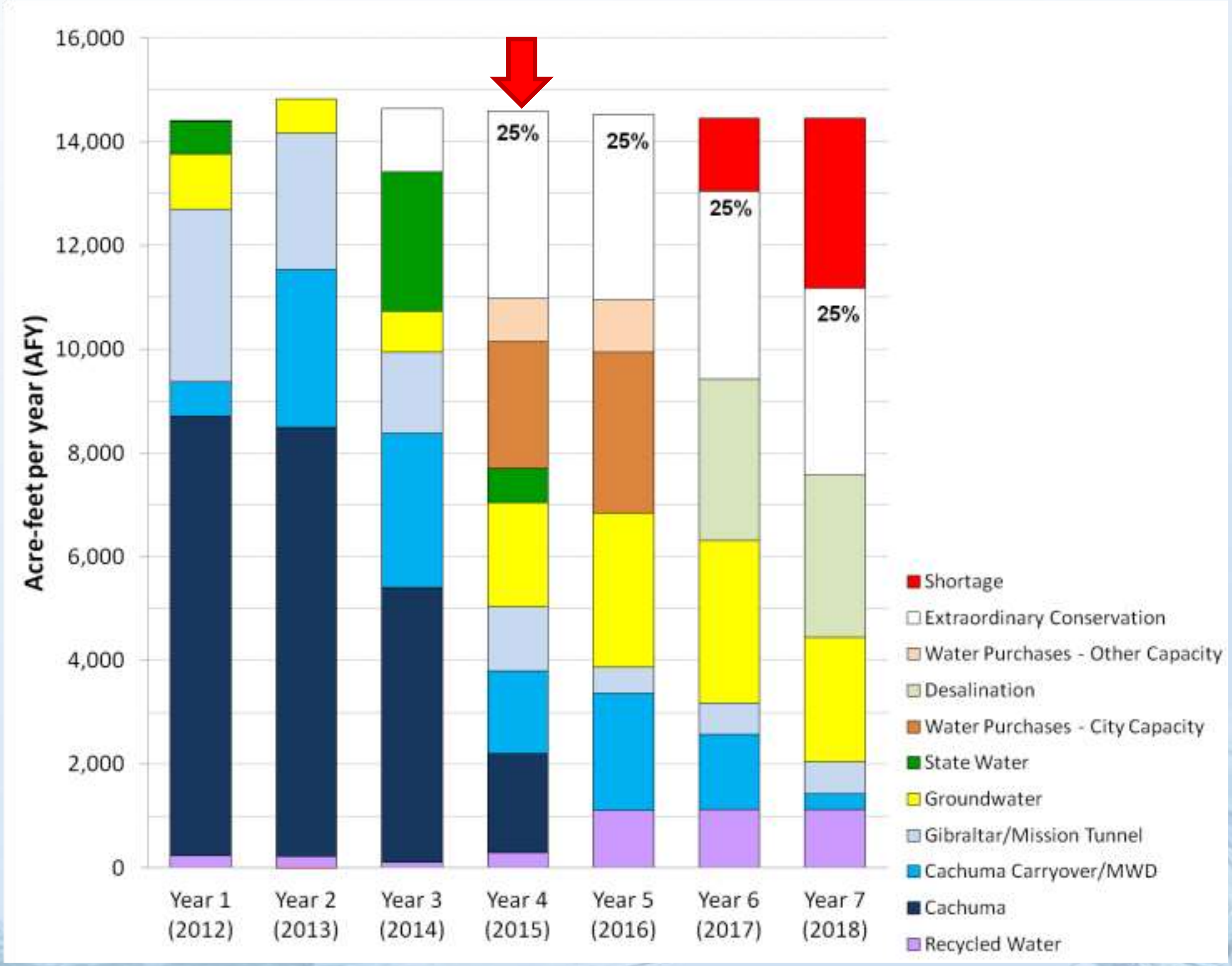
- Increased groundwater pumping
- Import banked and purchased water
- Demand reduction
  - Rates
  - Regulations
- Desalination



Charles Meyer Desalination Plant

Based upon current drought, City will need desalinated water supply by <u>Fall 2016</u> (start of Water Year 2017)

Supply strategy/desalination timeline
(based on no reservoir inflows, no State Water)



The City is moving forward with the desalination plant reactivation

- June 2015 – City selects DBO contractor
  - IDE/Kiewit
- July 2015 – City Council approved $55-million SRF Loan
- August 2015 – DBO notice to proceed
- October 2016 – Desalination Plant operating

Feasibility Study

Background & Objectives

Both City Council & RWQCB have directed Public Works to study feasibility of subsurface intakes & potable reuse

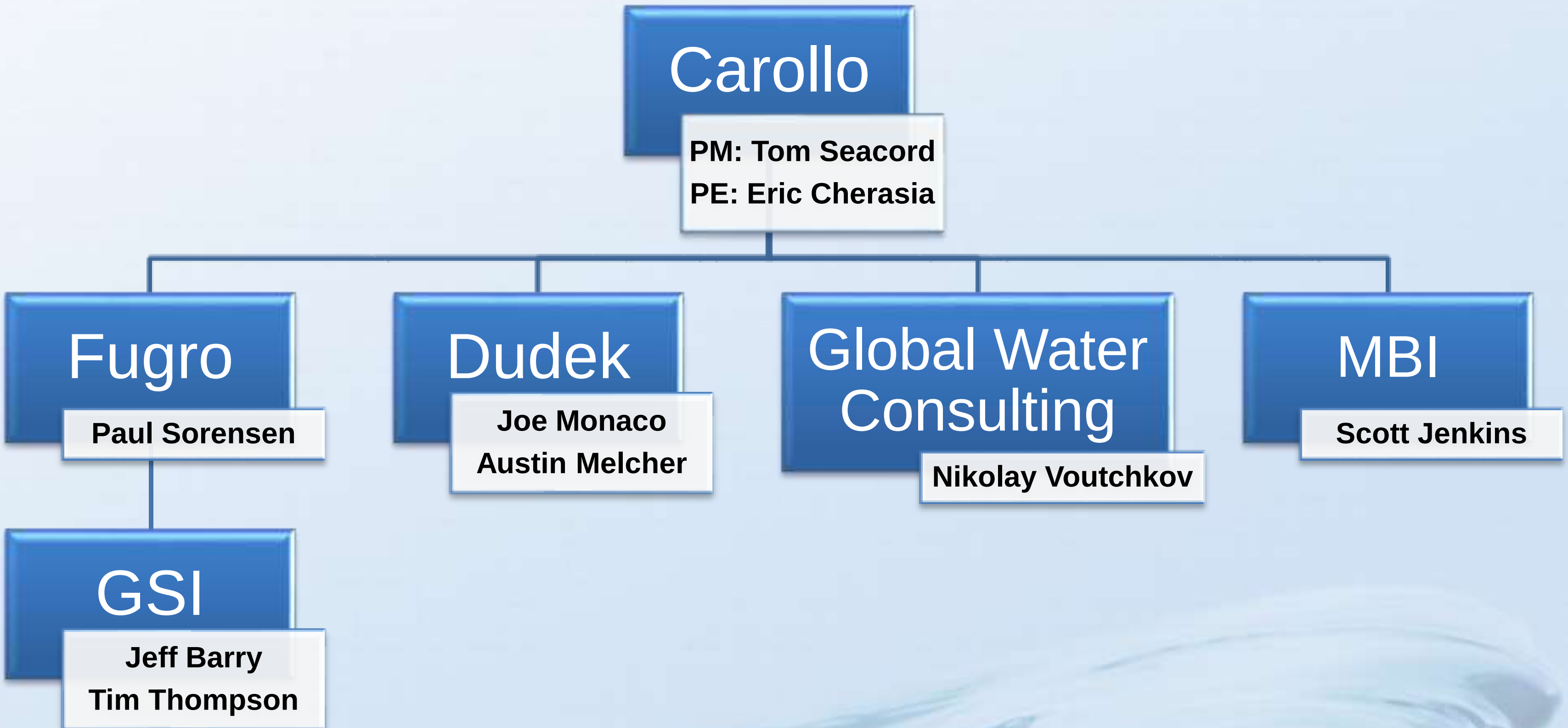
- September 23, 2014 – City Council directs public works staff to report back with a plan to evaluate:
  - Subsurface intakes
  - Indirect potable reuse/direct potable reuse (IPR/DPR)
- January 30, 2015 – RWQCB amended NPDES permit with a special condition requiring this study:
  - Work Plan approved by August 2015
  - Complete feasibility studies by June 2017

Study Scope & Work Plan Objective

- **Scope of Study:** "direct staff…[to evaluate the] feasibility, cost, and timeline associated with both converting the offshore facility to a subsurface intake and look at the options about potable reuse" (City Council 9/23/14)
- Scope does not include:
  - Determining best alternative
- Scope does include:
  - Identifying feasible alternatives
- **Work Plan Objective**: Establish the process and criteria used to evaluate feasibility

Project team is complemented by engineering, environmental & geotechnical experts

- June 16, 2015 – City hires Carollo team



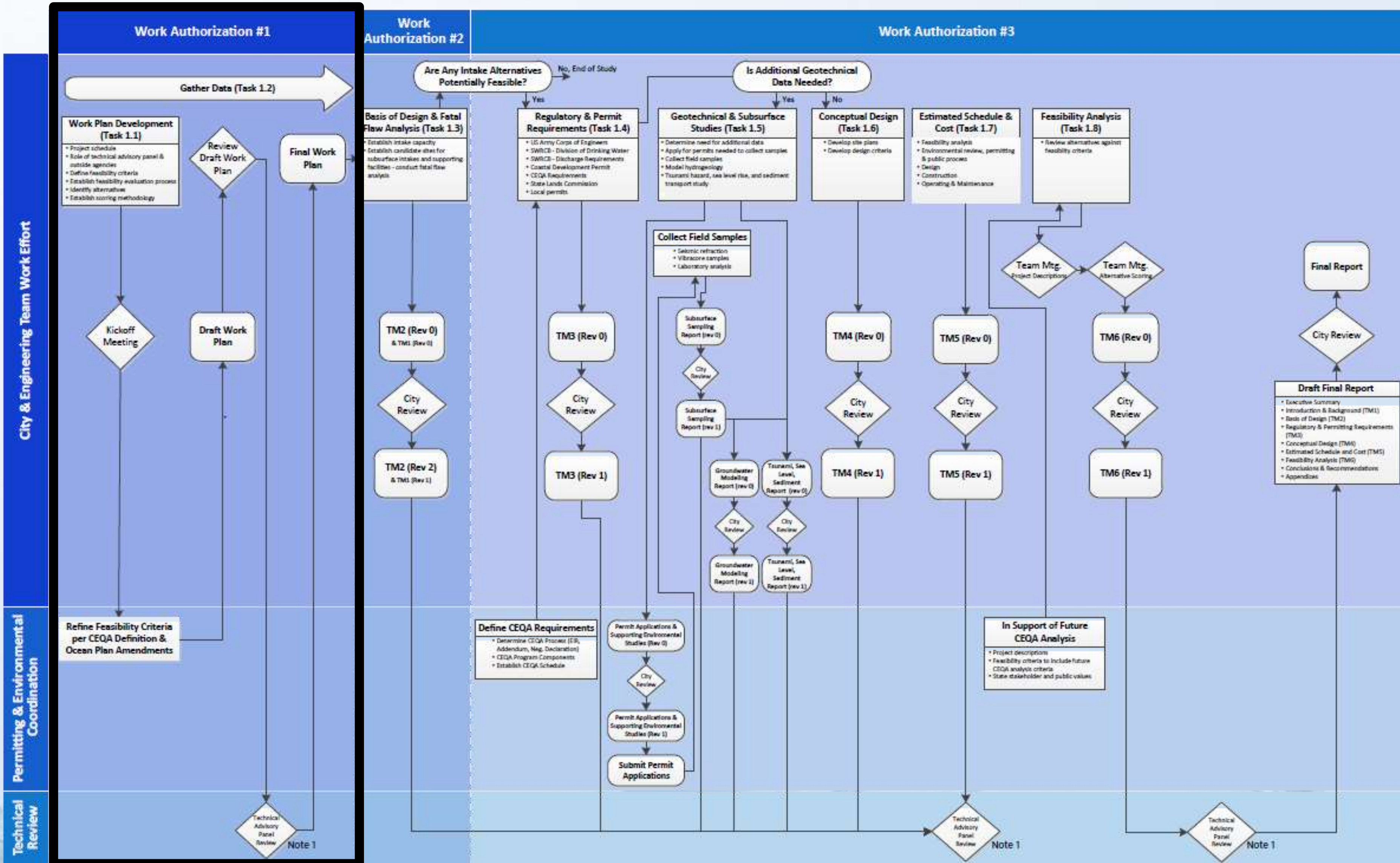
Three work authorizations - allows incorporation of feedback from prior activities

- **Work Authorization 1**:
  - Development of Work Plans
- **Work Authorization 2**:
  - Fatal flaw analyses
  - Potable reuse feasibility study
- **Work Authorization 3**:
  - Subsurface intake feasibility study

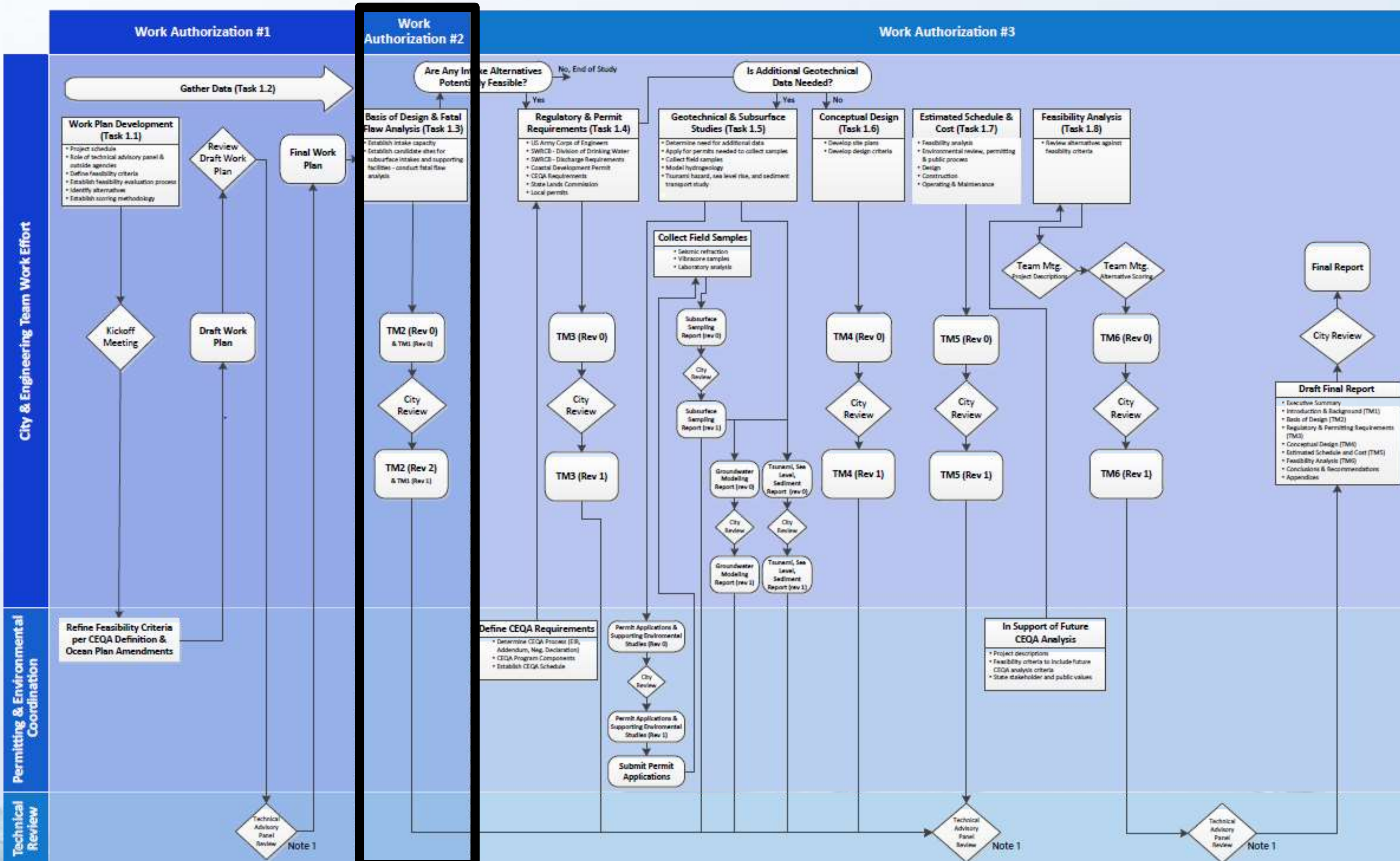
Work Plan has 7 areas that define how the study will be conducted

1. Introduction
2. Basis of Design
3. Feasibility Criteria (& Fatal Flaws)
4. Implementation Schedule Development
5. Cost Estimating Methodology
6. Feasibility Analysis
7. Technical Advisory Process

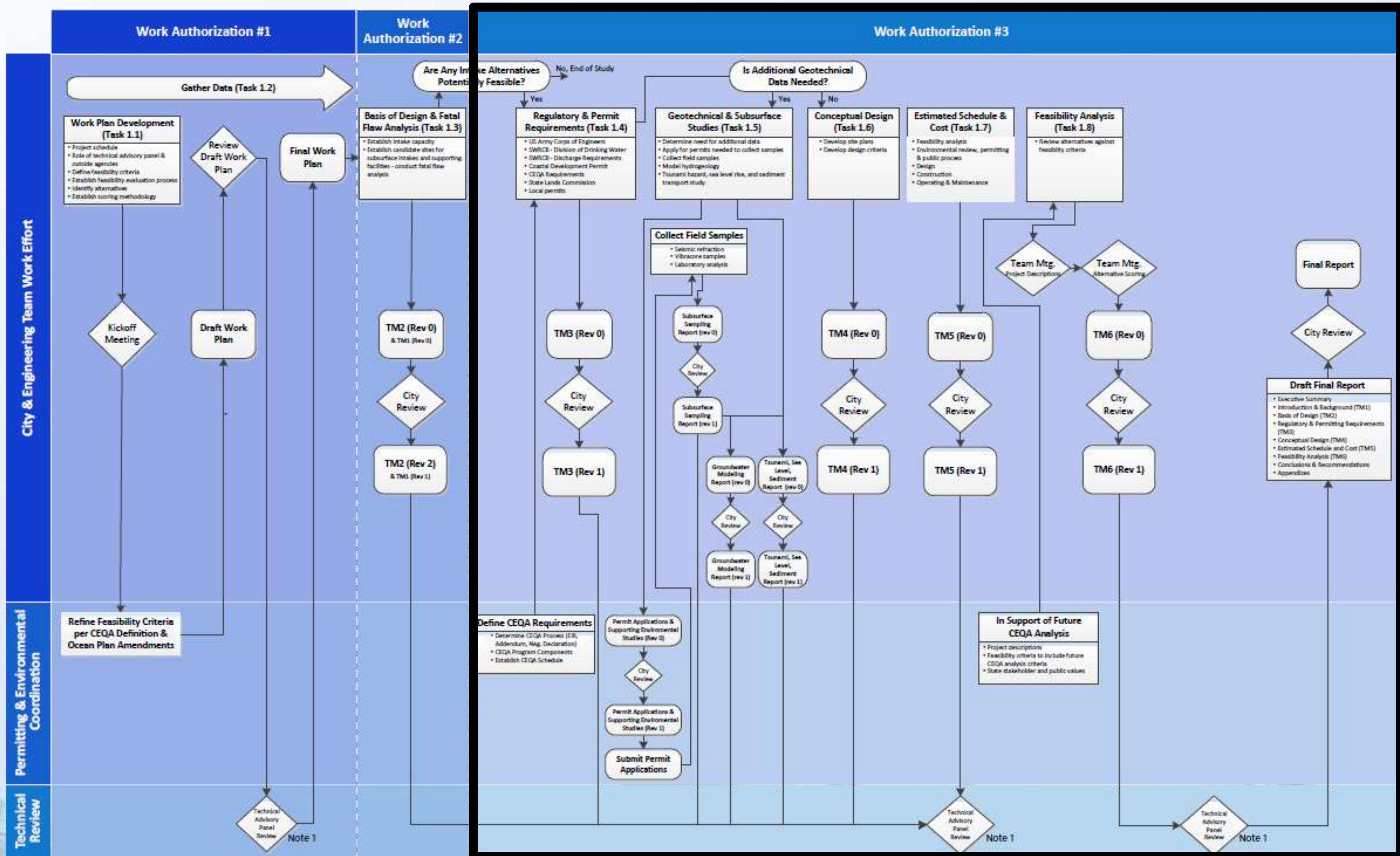
Subsurface Intake – Programmatic WPD



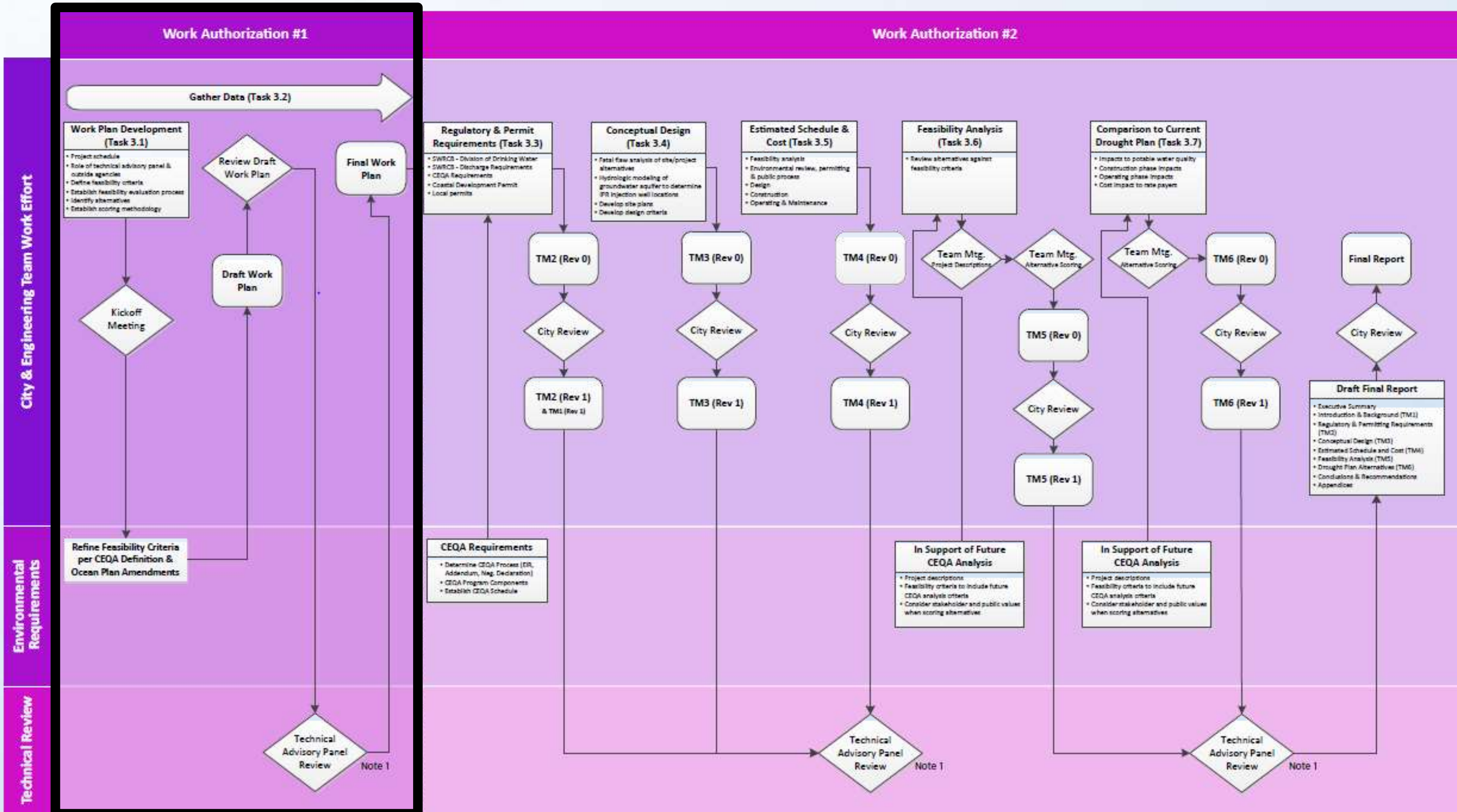
Subsurface Intake – Programmatic WPD



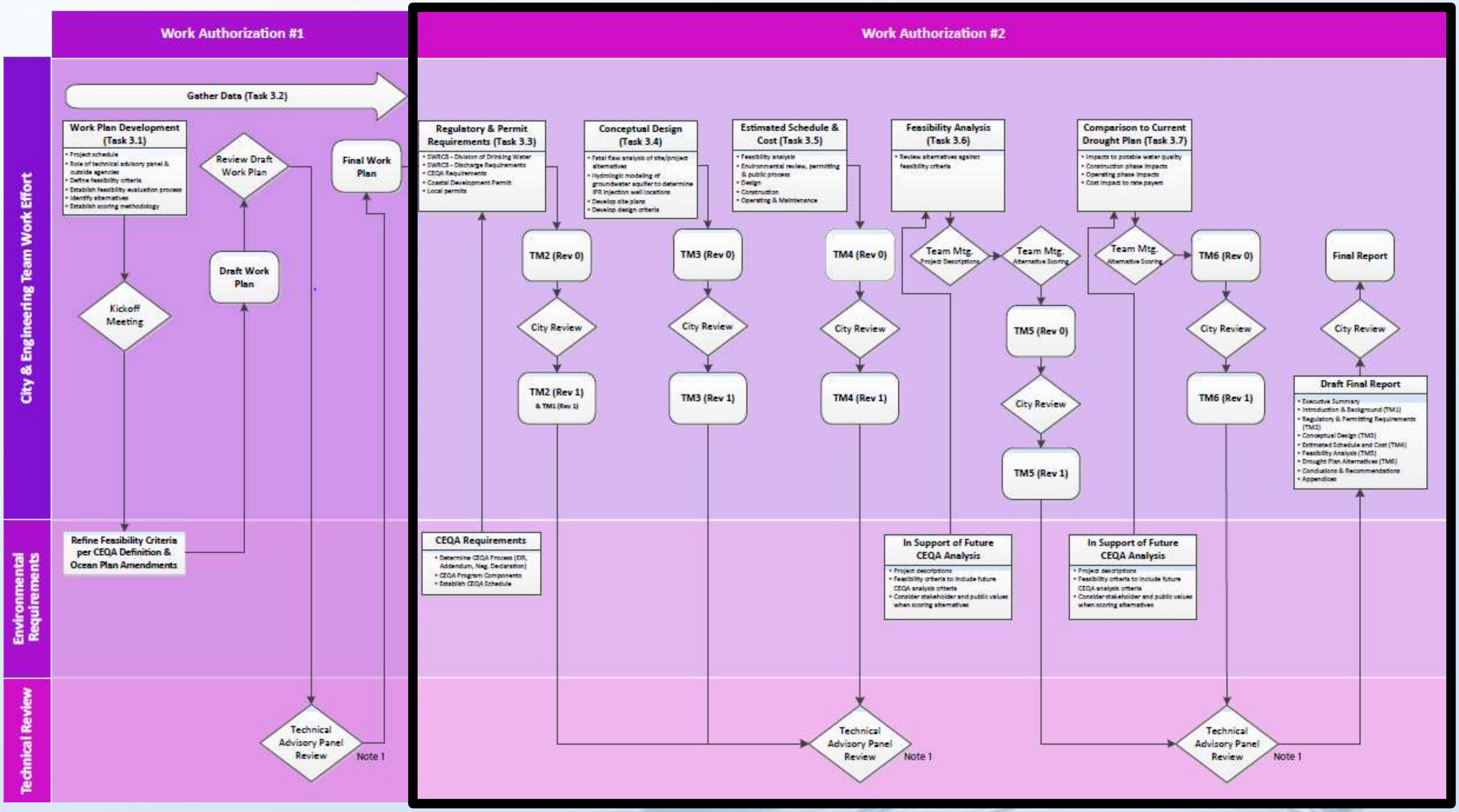
Subsurface Intake – Programmatic WPD



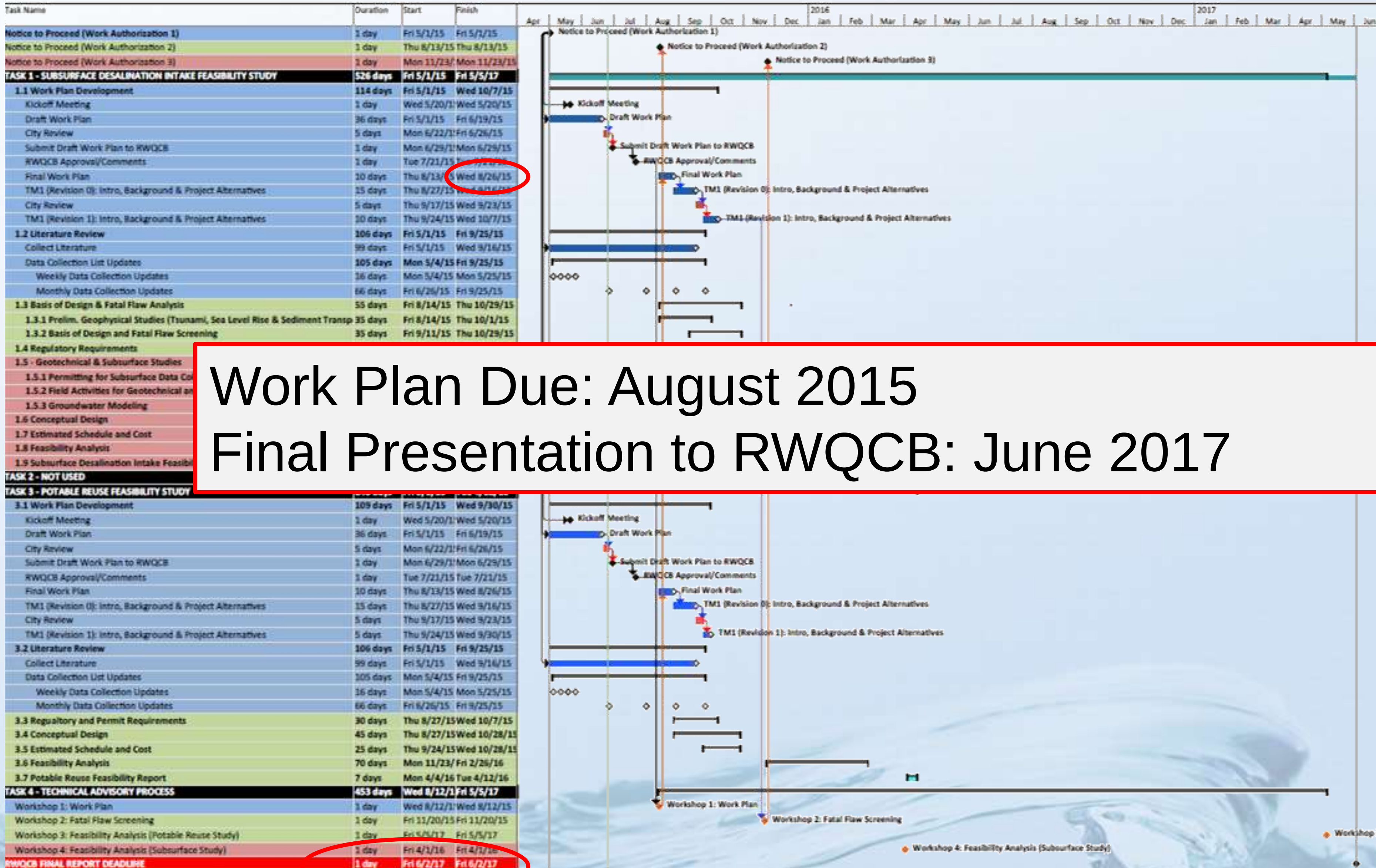
Potable Reuse – Programmatic WPD



Potable Reuse – Programmatic WPD



Permitting deadlines drive the project schedule



Work Plan Due: August 2015

Final Presentation to RWQCB: June 2017

Basis of Design

Subsurface Intake Study

Project capacity

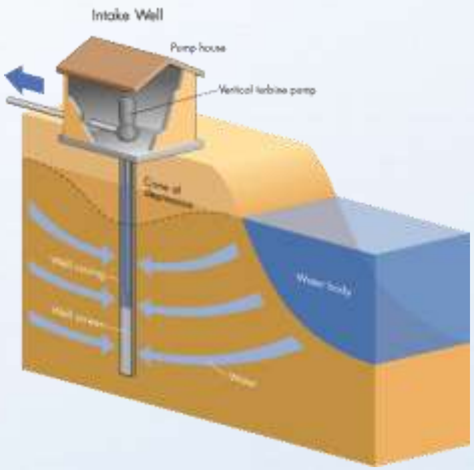
- Replace City's existing screened open ocean intake
- Provide seawater for buildout capacity of 10,000 AFY
  - Design capacity: 15,898 gpm
    - Includes:
      - 45% RO recovery
      - Volume of raw water needed for pretreatment backwashing

Site alternatives

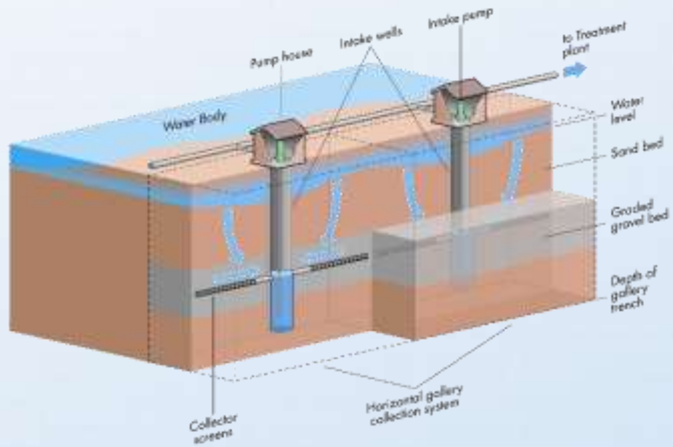
- Onshore/Offshore considered
  - Dependent on intake tech
- Offshore areas within ½ mile offshore considered
  - Simplifies property acquisition

Intake technologies

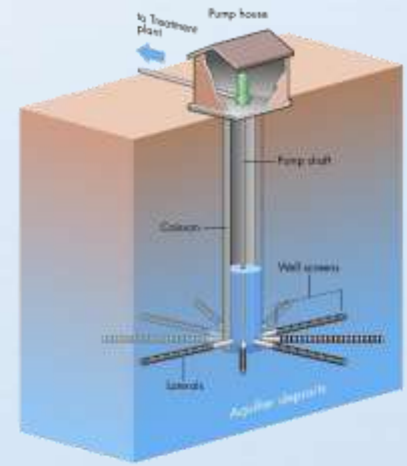
- Based on state of intake technology and recent studies conducted by others:



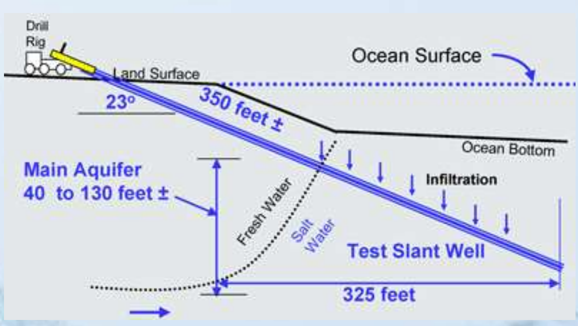
Vertical Wells



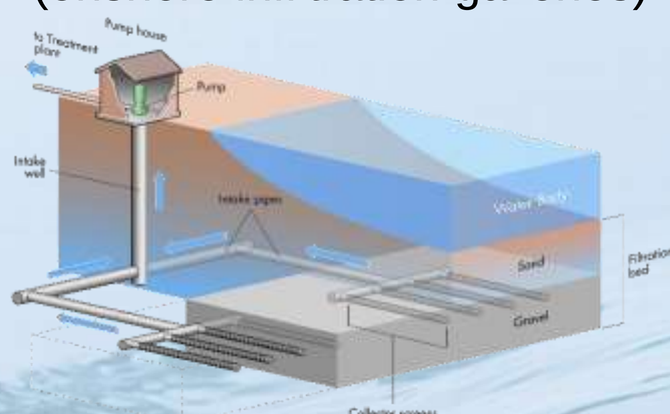
Lateral Beach Wells
(onshore infiltration galleries)



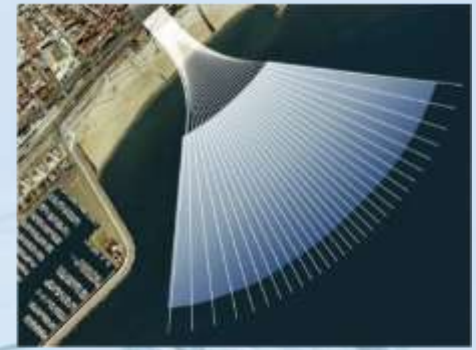
Horizontal Collector Wells
(i.e., Ranney Wells)



Slant Wells



SIG – offshore



HDD wells
(i.e., Neodren)

Geotechnical & hydrogeologic properties

- Literature review & other sources (e.g., USGS)
  - Numerous sources presented in Work Plan
- Additional data collection
  - If hydrologic data is not available, alternative is “potentially feasible” and additional data collection is recommended
    1. Geophysical survey along beach and shore area
    2. Drilling of core holes and installation of piezometers

Permitting for field data collection may have schedule impact

Oceanographic hazards

Tsunami (Coastal) Hazard Analysis

- Two phases:
  - Landside
  - Waterside
- Fundamental inputs:
  1. Extreme wave height
  2. Local water depth
  3. Depth/slope sediment cover over bedrock

Sediment Transport Analysis

- Optimal – neither erosional or depositional
- Feasible hydraulic pathway to desal facility
- Littoral Cell: complete cycle of sedimentation
  - Sources, paths, sinks

Oceanographic hazards

Tsunami (Coastal) Hazard Analysis

- Two phases:
  - Landside
  - Waterside
- Fundamental inputs:
  1. Extreme wave height
  2. Local water depth
  3. Depth/slope sediment cover over bedrock
- Coastal Evolution Model (CEM)

Sediment Transport Analysis

- Optimal – neither erosional or depositional
- Feasible hydraulic pathway to desal facility
- Littoral Cell: complete cycle of sedimentation
  - Sources, paths, sinks
- Santa Barbara Littoral Cell
  - CEM model
  - Used during validation

Water quality & treatment needs

- Subsurface intake systems may reduce RO pretreatment needs
  - Literature data will be used to establish pretreatment requirements
    - e.g., Long Beach, Morro Bay, Doheny Beach
  - Pretreatment process exists at desalination plant already
    - Compatibility of pretreatment will be assessed
    - Avoided costs (±) will be estimated using subsurface intake

Design & construction constraints

- Work plan describes methods to estimate:
  - Intake yield, facility spacing, and length of beach required
  - Percentage of ocean water
  - Impacts to local groundwater & sensitive habitats
  - Potential capture of known groundwater contamination

Project life & reliability

- 20-year project life assumed
- Reliability based upon:
  - Intake type
  - Hydrogeology
  - Geochemistry
  - Other site specific factors
- Safety factor established to address
  - Downtime for maintenance/repairs
  - Decrease in production (plugging)

Feasibility Criteria & Fatal Flaws

Subsurface Intake Study

Feasibility

- Definition in 2012 CEQA Statute & Guidelines
  - "Feasible means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, & technological factors"
- Ocean Plan Amendments (Adopted May 6, 2015)
  - Identify 13 factors to determine feasibility of subsurface intakes

Feasibility factors for subsurface intakes

1. Geotechnical data
2. Hydrogeology
3. Benthic topography
4. Oceanographic conditions
5. Presence of sensitive habitats
6. Presence of sensitive species
7. Energy use
8. Impact on freshwater aquifers, local water supply, and existing water users
9. Desalinated water conveyance
10. Existing infrastructure
11. Design constraints (engineering constructability)
12. Project life cycle costs
13. Other site & facility specific factors

Feasibility criteria (see Table 3.1 in Subsurface Intake Work Plan)

Feasibility Criteria	CEQA Feasibility Criteria			
	Technological Factors	Social Factors	Environmental Factors	Economic Factors
Geotechnical factors	X			
Hydrogeology factors	X	X	X	
Benthic topography	X			
Oceanographic factors	X			X
Presence of sensitive habitats	X		X	
Energy use	X		X	X
Design and construction constraints	X	X	X	X
Other site-specific factors		X		X
Economic factors		X		X

Feasibility criteria (see Table 3.1 in Subsurface Intake Work Plan)

Feasibility Criteria	CEQA Feasibility Criteria			
	Technological Factors	Social Factors	Environmental Factors	Economic Factors
Geotechnical factors	**X**			
Hydrogeology factors	**X**	X	X	
Benthic topography	**X**			
Oceanographic factors	**X**			X
Presence of sensitive habitats	**X**		X	
Energy use	X		X	X
Design and construction constraints	**X**	X	X	X
Other site-specific factors		X		X
Economic factors		X		X

Fatal flaw

- “Technological factors” in CEQA definition referred to as “technical feasibility”
- Certain technical feasibility criteria are fatal flaws
- “Fatal Flaw: Those technical factors that would not allow a full-scale system to be successfully constructed or operated, or would result in a high risk of failure, immitigable impact, or unacceptable performance of the City’s desalination plant at the raw water volume required for build-out conditions.”

Fatal flaw criteria

Fatal Flaw	Definition
Geotechnical Hazards	
Seismic hazard	Project facilities would cross a known fault line, or be exposed to a seismic hazard that could otherwise not be protected from loss by design
Hydrogeologic Factors	
Operation of subsurface intake adversely impacts existing fresh water aquifers, local water supplies, or existing water users	• Volume of groundwater in storage is reduced due to subsurface intake pumping, impacting drought supply and requiring additional desalination to make up for loss of groundwater • Operation of subsurface intake causes salt water intrusion into groundwater aquifers
Operation of subsurface intake adversely impacts sensitive habitats such as marshlands, drainage areas, etc.	Operation of subsurface intake drains surface water from sensitive habitat areas or adversely changes water quality
Insufficient length of beach available for replacing full yield derived from the existing open ocean intake	Small individual facility yield, large number of facilities required, and minimum spacing between facilities requires more shoreline than is available

Fatal flaw criteria (cont'd)

Fatal Flaw	Definition
Benthic Topography	
Land type makes intake construction infeasible	Depth to bedrock too shallow (i.e., less than 40-feet deep); rocky coastline; cliffs
Oceanographic Factors	
Erosion, sediment deposition, sea level rise or tsunami hazards	Oceanographic hazards make aspects of the project infrastructure vulnerable in a way that cannot be protected and/or would prevent the City from being able to receive funding or insurance for this concept
Presence of Sensitive Habitats	
Proximity to marine protected areas	Location would require construction within a marine protected area

Fatal flaw criteria (cont'd)

Fatal Flaw	Definition
Design and Construction Constraints	
Adequate capacity	Subsurface material lacks adequate transmissivity to meet target yield of at least 15,898 gpm (i.e., build-out intake capacity necessary to produce 10,000 AFY)
Lack of adequate linear beach front for technical feasibility	Length of beachfront available is not sufficient for construction of the required number of wells of all or portion of intake to meet target yield
Lack of adequate land for required on-shore facilities	• Surface area needed for on-shore footprint of an intake unit is greater than the available onshore area • Requires condemnation of property for new on-shore intake pumping facilities
Lacking adequate land for on-shore construction staging	The amount of land available to stage construction does not meet need
Precedent for subsurface intake technology	Intake technology has not been used before in a similar seawater or fresh water application at a similar scale)

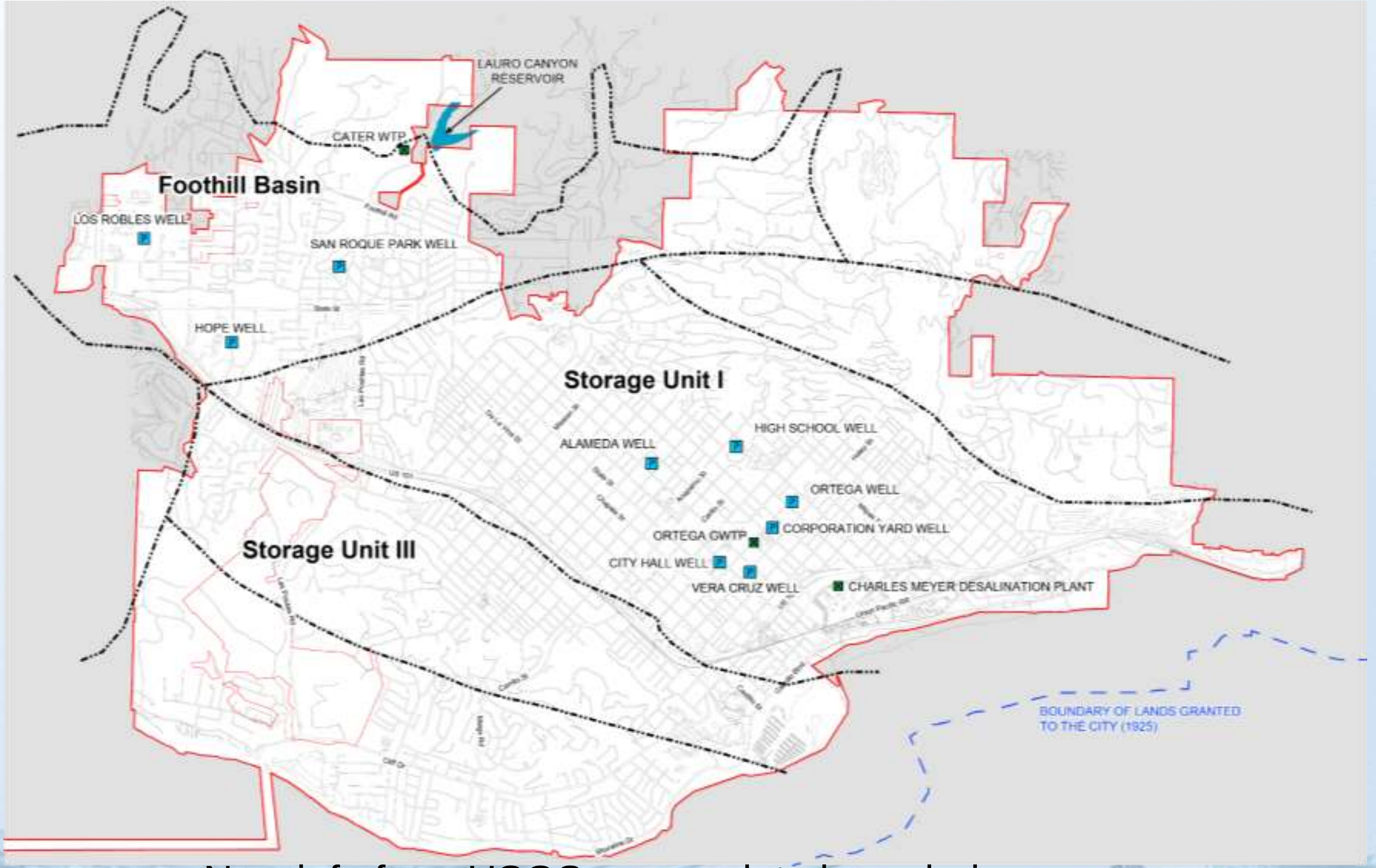
Basis of Design

Potable Reuse Study

Production capacity

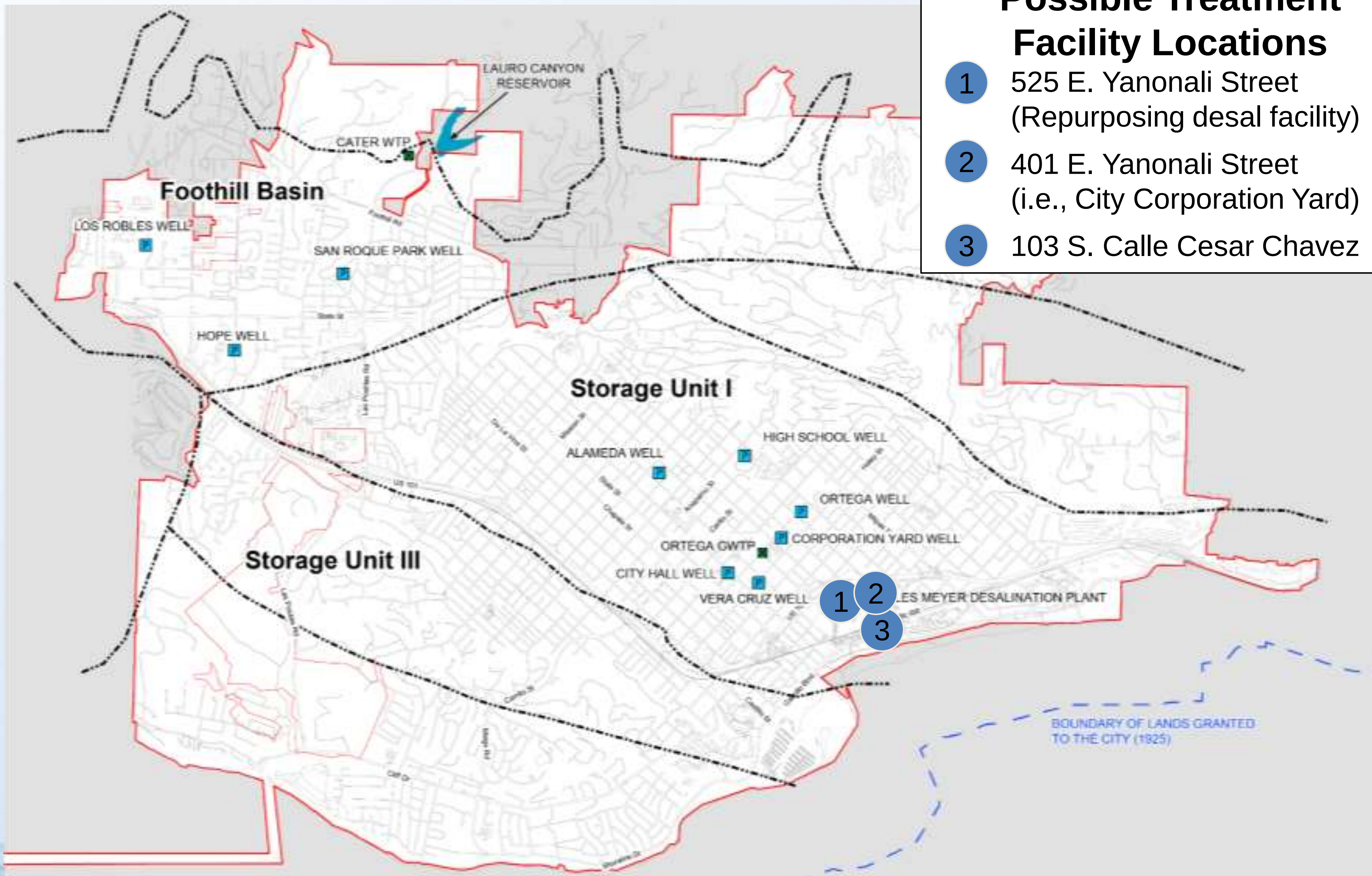
- Replace City's existing screened open ocean intake
- Provide up to the desal facility's buildout capacity of 10,000 AFY
  - City produces 1,400 AFY of non-potable recycled water
  - Combined potable and non-potable reuse capacity must be 11,400 AFY
- El Estero WWTP effluent availability and variability
  - Size plant on avg day flows

Project site & potable reuse alternatives



- New info from USGS may update boundaries

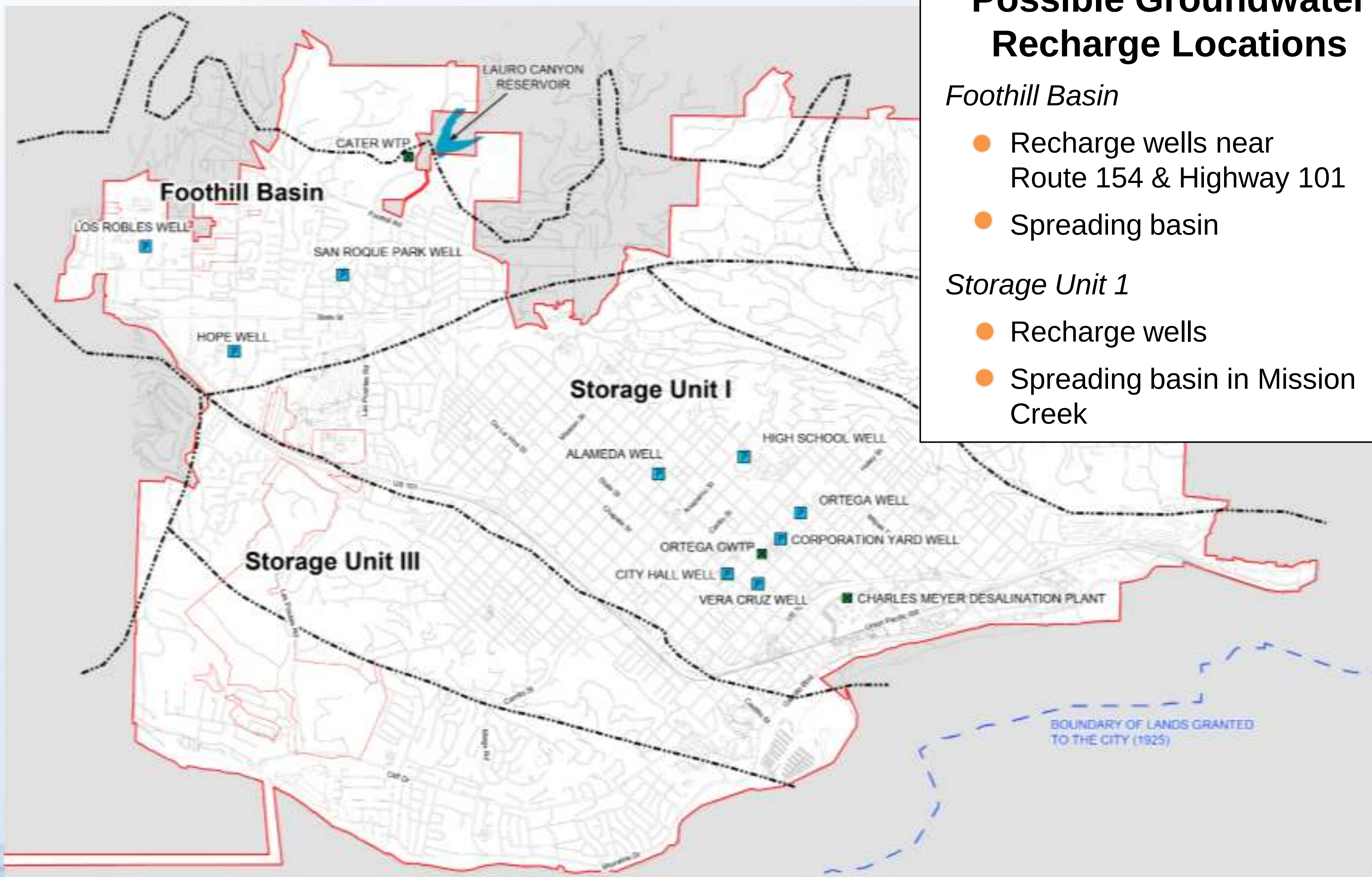
Project site & potable reuse alternatives



Possible Treatment Facility Locations

1. 525 E. Yanonali Street (Repurposing desal facility)
2. 401 E. Yanonali Street (i.e., City Corporation Yard)
3. 103 S. Calle Cesar Chavez

Project site & potable reuse alternatives



Possible Groundwater Recharge Locations

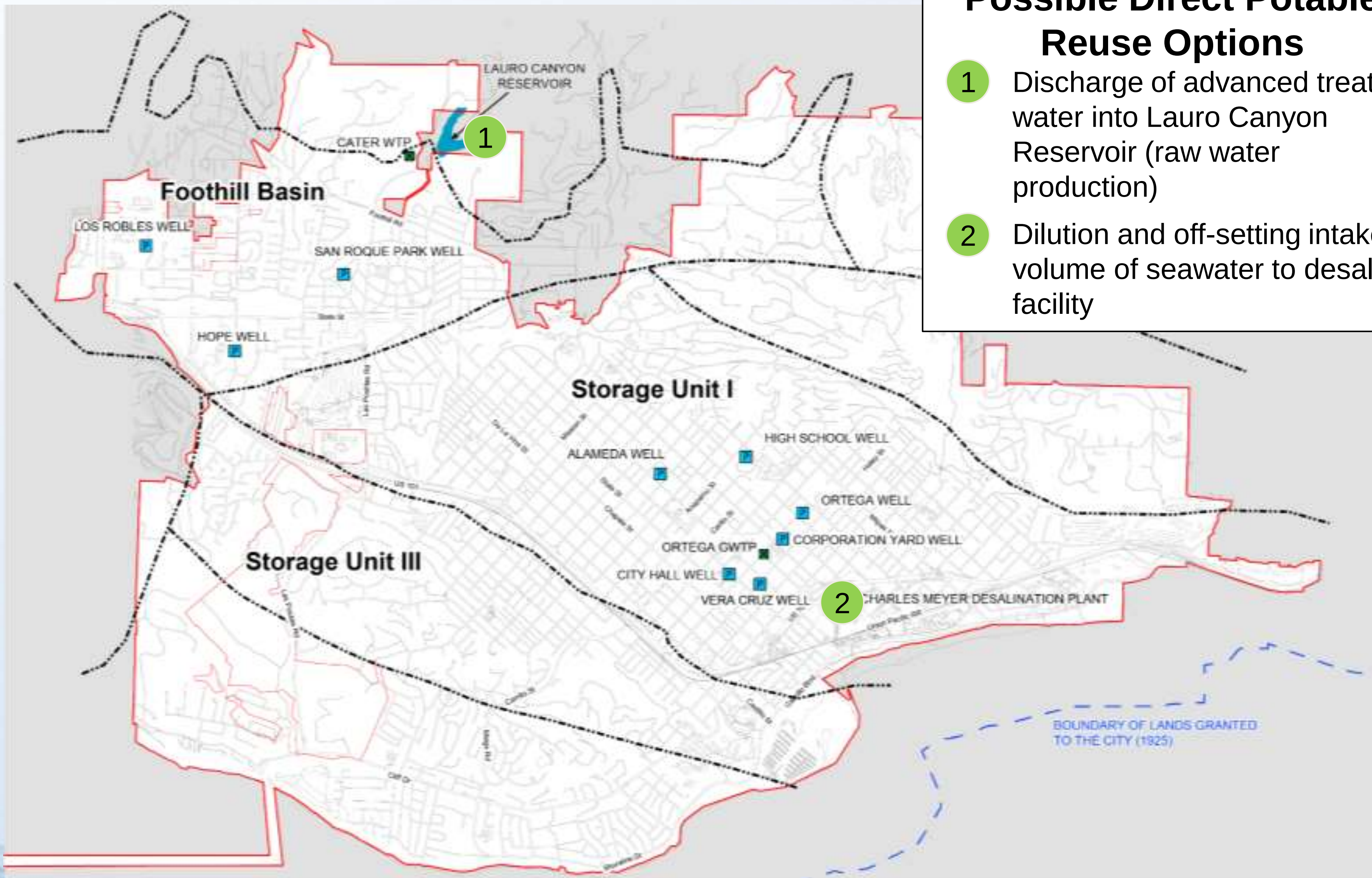
Foothill Basin

- Recharge wells near Route 154 & Highway 101
- Spreading basin

Storage Unit 1

- Recharge wells
- Spreading basin in Mission Creek

Project site & potable reuse alternatives



Possible Direct Potable Reuse Options

1. Discharge of advanced treated water into Lauro Canyon Reservoir (raw water production)
2. Dilution and off-setting intake volume of seawater to desal facility

Water quality & treatment needs

IPR Alternatives

- CCR, Title 22
- IPR regulations for groundwater replenishment
  - Spreading basins
  - Injection wells

DPR Alternatives

- No CA Regulations yet
- DDW will review DPR projects on a case by case basis
- Likely include:
  - Tmt in excess of Title 22
  - Enhanced disinfection
  - Engineered storage buffer

Geotechnical & hydrogeologic properties

- Literature review
  - Numerous sources presented in Work Plan
    - Including County-wide Reuse Study
- Additional data collection will be recommended if sufficient data is not available; for example:
  1. Aquifer test at existing locations
  2. Geophysical survey near recharge sites

Design & construction constraints

- Rate of groundwater recharge at target locations
  - Surface recharge: infiltration rates, low permeability layers, depth to groundwater
  - Injection wells: aquifer transmissivity, well design, depth to water, flow limiting barriers
- Available storage in production zone aquifers
  - City/USGS model for Santa Barbara Basin
- Existing basin and well yield increases
  - USGS model and analytical methods

Other project design criteria

- Impacts to local groundwater supplies and existing water users
- Impacts to sensitive habitats
- Potential capture or mobilize known groundwater contamination
- Additional production wells

Project life & reliability

- 20-year project life assumed
- Reliability based upon:
  - Production capacity
  - Source water quality
  - Potable reuse alternative
  - Hydrogeology
  - Other site-specific factors
- Safety factor established to address
  - Downtime for maintenance/repairs
  - Decrease in recharge capacity

Feasibility Criteria & Fatal Flaws

Potable Reuse Study

Feasibility criteria (see Table 3.1 in Potable Reuse Work Plan)

Feasibility Criteria	CEQA Feasibility Criteria			
	Technological Factors	Social Factors	Environmental Factors	Economic Factors
Geotechnical factors	X			
Hydrogeologic factors	X	X	X	
Oceanographic factors	X			X
Presence of sensitive habitats	X		X	
Energy use	X		X	X
Design and construction constraints	X	X	X	X
Other site-specific factors		X	X	X
Economic factors		X		X

Feasibility criteria (see Table 3.1 in Potable Reuse Work Plan)

Feasibility Criteria	CEQA Feasibility Criteria			
	Technological Factors	Social Factors	Environmental Factors	Economic Factors
Geotechnical factors	**X**			
Hydrogeologic factors	**X**	X	X	
Oceanographic factors	**X**			X
Presence of sensitive habitats	**X**		X	
Energy use	X		X	X
Design and construction constraints	**X**	X	X	X
Other site-specific factors		X	X	X
Economic factors		X		X

Fatal flaw criteria

Fatal Flaw	Definition
Geotechnical Hazards	
Seismic hazard	Project facilities would cross a known fault line, or be exposed to a seismic hazard that could otherwise not be protected from loss by design
Hydrogeologic Factors	
Operation of groundwater recharge facilities (i.e., injection wells or spreading basin) adversely impacts existing fresh water aquifers, local water supplies or existing water users	• Insufficient travel time (e.g., < 2 months) between groundwater recharge point and other groundwater users
Operation of groundwater recharge facilities (i.e., injection wells or spreading basin) adversely impacts sensitive habitats such as marshlands, drainage areas, etc.	• Operation of facility adversely changes water quality of habitat (e.g., salt water habitat becomes fresh water).
Insufficient storage space	• Groundwater basin lacks adequate storage capacity to receive 10,000 AFY (or 11,400 AFY) at build-out • Groundwater recharge of IPR water causes loss of ability to adequately manage the groundwater basin (e.g., artesian or flooding conditions, loss of stored water, etc.) • Groundwater recharge of IPR water does not result in an increase in total basin yield and overall yield of 10,000 AFY (or 11,400 AFY)

Fatal flaw criteria (cont'd)

Fatal Flaw	Definition
Oceanographic Factors	
Sea level rise or tsunami hazard	Oceanographic hazards make aspects of the project infrastructure vulnerable in a way that cannot be protected and/or would prevent the City from being able to receive funding or insurance for this concept
Presence of Sensitive Habitats	
Habitat creation	Facility creates habitat that is unsustainable (i.e., requires continued discharge by IPR facility) or adversely affects local ecosystem
Design and Construction Issues	
Adequate capacity	• Availability of effluent needed to produce 10,000 AFY (or 11,400 AFY) of recycled water at build-out • IPR production capacity and/or aquifer losses result in less than 10,000 AFY (or 11,400 AFY) of production at build-out
Lack of adequate land for required for IPR treatment or groundwater recharge facilities	• Surface area needed for footprint of IPR treatment or groundwater recharge facilities is greater than what is available • Requires condemnation of property for new injection well facilities

Implementation Schedule, Cost Estimate & Feasibility Analysis*

***Only feasible or potentially feasible alternatives are carried forward**

Implementation schedule development

- Major components:
  1. Planning phase (feasibility studies)
  2. Test facility or test well demonstration
  3. Implementation of full-scale system
- Schedule inclusive to all project components:
  - Property easement acquisition
  - Design
  - Permitting
  - Environmental
  - Bid phase
  - Construction
  - Operation

Cost estimating methodology

- Class 4 estimate
  - Parametric models, specific analogy, trend analysis
  - Includes:
    - Feasibility analysis, environmental review, permitting, public process, property and easement acquisition, design, construction, O&M

Feasibility analysis

- All factors from Feasibility Criteria table
  - Advantages/Disadvantages presented for each
- Considers factors:
  - Technological
  - Social
  - Environmental
  - Economic

Technical Advisory Process

TAP has 3 primary objectives

1. Provide timely review of project work products and guide studies
   - By subject matter experts
2. Facilitate input from project stakeholders
   - Used to inform City’s evaluation of potentially feasible alternatives
3. Create a record of the review and stakeholder process
   - Included as appendix to feasibility study report

Work Plan defined TAP process

- Facilitated by NWRI
  - Non-profit; has facilitated similar programs for municipal and state regulatory agencies
- NWRI will:
  - Retain services of TAP members
  - Facilitate project meetings (including stakeholder comment)
  - Document technical review & stakeholder process
- Moderator: Jeff Mosher, NWRI

NWRI has selected TAP panelists with experience in the required project areas

- Amy Childress, Ph.D., (Panel Chair)
  - University of Southern California
- Heather Collins
  - Metropolitan Water District of Southern California
- Martin B. Feeney, P.G., C.E.G., C.Hg.
  - Consulting Hydrogeologist
- Heidi R. Luckenbach, P.E.
  - City of Santa Cruz Water Department
- Eric Zigas
  - Bay Area Water Group, Environmental Science Associates

Work Plan defines TAP meetings & format

- Workshop 1: Work Plan
- Workshop 2: Fatal Flaw Analysis
- Workshop 3: Potable Reuse Feasibility Study
- Workshop 4: Subsurface Desalination Intake Feasibility Study
- Work product to TAP 15 days before a workshop
- NWRI:
  - Distribute to TAP
  - Post material to project website (@ least 5 days prior)
  - Create and distribute agendas

Stakeholder process

- Comment cards used to record issues, feedback, or comments
  - Shall be submitted 10 minutes prior to comment period
- Stakeholders given 2 minutes for comment
  - Can yield time to another individual
- Not required to attend workshop to record comments
  - Comments can be submitted to NWRI within 5 working days of workshop

http://www.nwri-usa.org/santa-barbara-panel.htm

PROJECT WEBSITE

RWQCB approval of work plan is required by end of August 2015

- NWRI provides report of TAP and stakeholder comments to City
- City addresses TAP comments; responds to stakeholder comments
- City submits Work Plans & TAP Report to RWQCB for approval

Subsurface Desalination Intake & Potable Reuse Feasibility Studies

TAP Workshop #1

City of Santa Barbara, California

August 5, 2015

Engineers...Working Wonders With Water®

Desalination facilities are updated with modern technology while maintaining consistency with existing permits

Production capacity (cont'd)

- Capacity of each alternative based on:
  1. Avg day flows with storage used to buffer changes in diurnal flow rates
     - Sizing plant on average day flow condition ensures facility's equipment well utilized.
  2. Full treatment by reverse osmosis for potable reuse stream @ 80% RO recovery
  3. Recycle of BW water from microfiltration and other non-potable reuse treatment filter systems to head of WWTP
     - Optimize recovery and reuse of flow streams