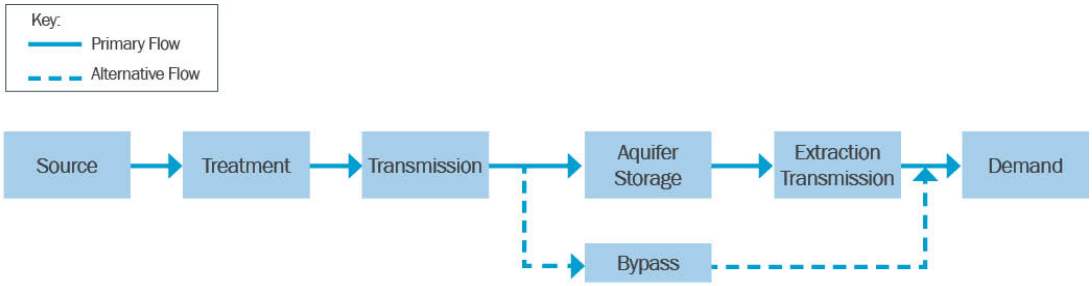
City of Santa Cruz Water Supply Advisory Committee
Solutions Phase -- Technical Summary

Consolidated Alternative 07 - Deepwater Desalination

This alternative would desalt seawater withdrawn through a new deepwater intake system at Moss Landing, producing approximately 10,000 AFY at the facility start up and up to approximately 25,000 AFY in the future. From that annual production the City would purchase 500 MG through a "take-or-pay" agreement. SqCWD also would purchase a similar quantity. The City and SqCWD would share the transfer facilities to move the water up coast. In average and wet years the SqCWD would take the full allotment for its needs as well as conjunctive use and/or aquifer storage and recovery (ASR). In drought years the City would draw its share together with aquifer-stored water from SqCWD. The block diagram below presents this alternative schematically.

This alternative has several outstanding issues, e.g., environmental document completion, permitting through the California Coastal Commission, and public vote approving alternative implementation.



SCHEMATIC OVERVIEW - KEY COMPONENTS FOR CA-07 DEEPWATER DESALINATION

Description: Deepwater desalination for demands during dry periods.

Applicable WCAs: WCA - 19 ("McGilvray: (11) Seawater Desal"), WCA - 36 ("Aqueous: Desalination [non-membrane]"), WCA - 37 ("Brown: Zero-Emission Wave Energy"), WCA- 67 ("Tanaka"), WCA- 72 ("Seawater Desalination - Deepwater Desalination").

Estimated Annual Yield (million gallons [MG]) [Yield will vary, adjusted later, depending upon results from Confluence modeling and findings from Pueblo regarding aquifer volume available for storage.]	500 (up to 1,000 MG in drought years)

Reliability Over Time (seasonal and inter-annual variability)

Costs	Best Estimate	Likely Range	Comments
Capital Cost ($million/MGD)	117	77 to 124	
Annual ($million)	$1.30	TBD	
Present Value	TBD	TBD	
Capital cost/MG annual capacity	234,000	154,000 to 248,000	
PV Cost/MG	TBD	TBD	
Energy (KWh/MG)	13,000	11,000 to 15,000	

Key Components

1. Deepwater marine intake and pipeline or tunnel to shore.	4. Brine storage and brine disposal pipeline.
2. Onshore pumping station.	5. Pump stations and pipelines for distribution/transmission.
3. Desalination facility.	6. Improvements to the City distribution system to transfer water from SqCWD.

Implementation Requirements Summary

Complete CEQA process. Obtain voter and City Council approval. Negotiate agreement with SqCWD and with project developer. Design, bid, build, and commission new facility.

Required Land Area (acres)	N/A

Permitting Summary

Completion of CEQA process. California Coastal Commission approval.

EVALUATION

Technical Feasibility

Widely used.
Desal technology is widely used.

Legal Feasibility

Yes, but some ambiguities.
Water sharing agreement would need to be worked out with SqCWD; assumes facilities (pump stations, pipes, wells, etc.) would be located within Public ROW.

Regulatory Feasibility

Very slow, no regulatory change.
Assumes that considerable time to complete the environmental and regulatory process will be needed.

City of Santa Cruz Water Supply Advisory Committee
Solutions Phase -- Technical Summary

Consolidated Alternative 07 - Deepwater Desalination

Political Feasibility
Active resistance now.
Based on response to SCWD2 desal project, it is assumed there will be resistance but this may be overcome.

Regional Water Benefits
2 jurisdictions
Directly would impact SqCWD and SCWD.

Local Economy
Positive local.
Assumes a more stable water supply impacting a larger portion of the county will have a positive impact.

Energy
5
Desal facilities require considerable amounts of energy; pumping system will also require energy for this distance.

Marine Ecosystem Health
May harm.
Though deepwater desal is likely to have less negative impact on the marine environment, some negative impact is assumed.

Freshwater and Riparian Health
About as it is now.
Assume this ecosystem will not be modified since this alternative only fills the shortfall and does not reduce current diversions.

Terrestrial Resources
TBD
Scale for this criterion has not been developed

Environmental Profile
The environmental profile of this portfolio is acceptable with appropriate and effective mitigation.
Assumes impacts would exist but could be mitigated.

Groundwater Resources
Allows restoration.
Assumes water City does not take during wet years could be used by SqCWD and the City for GW restoration.

Infrastructure Resilience
Meets most challenges well.
Assumes new infrastructure would be built to meet codes/regulations but prolonged power outages could impact system.

Supply Reliability
Makes system significantly more reliable.
Diversifies water supply portfolio with additional source not dependent on weather.

Scalability
Can scale up ~650MG.
Alternative notes 500MG but assumes this could be increased or decreased and is the range.

Preserves Future Choices
Somewhat increases choice.
Assumes City could take desal water in wet or average years to reduce diversions if agreements written with this flexibility.

Yield
500-1000 MG

Operational Flexibility
Greatly increases .
Does not rely on existing facilities to provide all water.

Addresses Peak Season Demand
Yes

Implementability
Could be implemented with some challenges.
Requires overcoming environmental, interagency, community resistance hurdles.

Supply Diversity
Portfolio greatly increases the diversity of Santa Cruz's supply portfolio.
Adds additional source that is drought proof than current portfolio

Sustainability
This portfolio is somewhat sustainable.
Assumes aspects of desal (high energy, brine) are not "sustainable" but overall system is sustainable.

Issues to Resolve
Marine intake and discharge locations and permits. Site acquisition for new facilities. Finalization of pipeline routes and ROW acquisition. Creating long-term contract with project developer and with SqCWD.

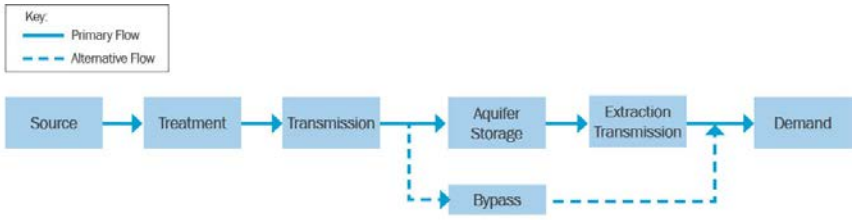
City of Santa Cruz Water Supply Advisory Committee
Solutions Phase -- Technical Summary

Consolidated Alternative 14 - Desal Using Forward Osmosis

This alternative would use seawater desalting through a forward osmosis (FO) system (e.g., Trevi Systems, Oasys Water, etc.) . This alternative's other components would match those for seawater desalting.

The alternative has several outstanding issues, e.g., FO technology is still in its infancy and being tested at a pilot or demonstration scale. As described, it would require a lower grade heat source or a RO system for separately drawing the solution from the potable water but the WCA alternative description did not designate a source for lower grade heat.

Since the FO is still at the developmental stage, BC has not developed this alternative further. If future testing and implementation by other entities prove its value, it could replace RO or serve as pretreatment ahead of either RO, IPR, or DPR if the City was to select and implement CA-11, CA-12 or CA-13. The block diagram below presents this alternative schematically.



SCHEMATIC OVERVIEW - KEY COMPONENTS FOR CA-14 DESAL USING FOWATER OSMOSIS

Description: Desalination with forward osmosis (FO) [note that this technology is still developmental]. Therefore this summary does not project

Applicable WCAs: WCA - 13 ("Trevi: Forward Osmosis Desalination").

Estimated Annual Yield (million gallons [MG])	500 (up to 1,000 MG in drought years)

Reliability Over Time (seasonal and inter-annual variability)

Costs	Best Estimate	Likely Range	Comments
Capital Cost			
Annual			
Present Value			
Capital cost/MG annual capacity			
PV Cost/MG			
Energy (KWh/MG)	6,000	5,000 to 7,000	

Key Components

1. Offshore seawater intake, pipelines, and pumping station, to deliver seawater to Trevi process site .	4. Waste heat for Trevi separation system or electric power for RO separation.
2. Pretreatment system such as DAF and MF for initial seawater cleaning.	5. Brine return pipeline.
3. Trevi process site to separate potable water and recover and return draw solution.	6

Implementation Requirements Summary

Required Land Area (acres)	

Permitting Summary

EVALUATION

Technical Feasibility

Promising in 6-10 years.
Assumes FO systems will reach commercial maturity within the decade.

Legal Feasibility

Yes, but some ambiguities.
Water sharing agreement would need to be worked out with SqCWD; assumes facilities (pump stations, pipes, wells, etc.) would be located within

Regulatory Feasibility

Very slow, no regulatory change.
Assumes that considerable time to complete the environmental and regulatory process will be needed.

City of Santa Cruz Water Supply Advisory Committee
Solutions Phase -- Technical Summary

Consolidated Alternative 14 - Desal Using Forward Osmosis

Political Feasibility
Active resistance now.
Based on response to SCWD2 desal project, it is assumed there will be resistance but this may be overcome.

Regional Water Benefits
2 jurisdictions
Directly would impact SqCWD and SCWD.

Local Economy
Positive local.
Assumes a more stable water supply impacting a larger portion of the county will have a positive impact.

Energy
5
Desal facilities require considerable amounts of energy; pumping system will also require energy for this distance.

Marine Ecosystem Health
May harm.
May have negative impact on the marine environment

Freshwater and Riparian Health
About as it is now.
Assume this ecosystem will not be modified since this alternative only fills the shortfall and does not reduce current diversions.

Terrestrial Resources
N/A

Environmental Profile
The environmental profile of this portfolio is acceptable with appropriate and effective mitigation.
Assumes impacts would exist but could be mitigated.

Groundwater Resources
Allows restoration.
Assumes water City does not take during wet years could be used by SqCWD and the City for GW restoration.

Infrastructure Resilience
Meets most challenges well.
Assumes new infrastructure would be built to meet codes/regulations but prolonged power outages could impact system.

Supply Reliability
Makes system significantly more reliable.
Diversifies water supply portfolio with additional source not dependent on weather.

Scalability
Can scale up ~650MG.
Alternative notes 500MG but assumes this could be increased or decreased and is the range.

Preserves Future Choices
Somewhat increases choice.
Assumes City could take desal water in wet or average years to reduce diversions if agreements written with this flexibility.

Yield
500-1000 MG

Operational Flexibility
Greatly increases .
Does not rely on existing facilities to provide all water.

Addresses Peak Season Demand
Yes

Implementability
Could be implemented with some challenges.
Requires overcoming environmental, interagency, community resistance hurdles.

Supply Diversity
Portfolio greatly increases the diversity of Santa Cruz's supply portfolio.
Adds additional source that is drought proof than current portfolio

Sustainability
This portfolio is somewhat sustainable.
Assumes aspects of desal (high energy, brine) are not "sustainable" but overall system is sustainable.

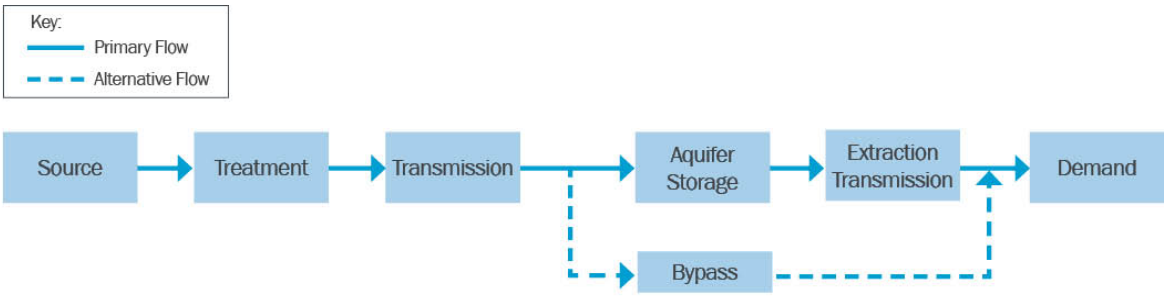
Issues to Resolve

City of Santa Cruz Water Supply Advisory Committee Solutions Phase -- Technical Summary
Consolidated Alternative 14 - Desal Using Forward Osmosis
The available data are only from field studies that Trevi Systems have done or are currently running. Source of waste heat to drive FO system needs to be identified. Forward osmosis might be a viable alternative to RO for producing highly purified CAT water.

City of Santa Cruz Water Supply Advisory Committee
Solutions Phase -- Technical Summary

Consolidated Alternative 15 - Desalination using Reverse Osmosis

This alternative would use seawater desalting through reverse osmosis to produce potable water at a City-owned facility. Excess water would be used for other water demands, such as conjunctive use, for example, transferred to SqCWD as potable water. SqCWD would use additional potable water for aquifer storage and recovery or for conjunctive use. SqCWD would return potable water to Santa Cruz, to make up for City shortfalls during droughts. Reverse osmosis is a proven technology, but has high capital and O&M costs. The block diagram below presents this alternative schematically. This alternative has several outstanding issues, e.g., environmental document completion, permitting through the California Coastal Commission, and public vote approving alternative implementation.



SCHEMATIC OVERVIEW - KEY COMPONENTS FOR CA-15 DESALINATION USING REVERSE OSMOSIS

Description: Desalination with reverse osmosis for potable water demands, and possible other water demands.

Applicable WCAs: WCA - 19 ("McGilvray: (11) Seawater Desal"), WCA - 36 ("Aqueous: Desalination [non-membrane]"), WCA - 37 ("Brown: Zero-Emission Wave Energy"), WCA - 67 ("Tanaka").

Estimated Annual Yield (million gallons [MG]) [Yield will vary, adjusted later, depending upon results from Confluence modeling and findings from Pueblo regarding aquifer volume available for storage.]	500 (up to 1,000 MG in drought years)

Reliability Over Time (seasonal and inter-annual variability)

Costs	Best Estimate	Likely Range	Comments
Capital Cost	TBD	TBD	
Annual	TBD	TBD	
Present Value			
Capital cost/MG annual capacity			
PV Cost/MG			
Energy (KWh/MG)	13,000	11,000 to 15,000	

Key Components

1	4
2	5
3	6

Implementation Requirements Summary

Required Land Area (acres)	

Permitting Summary

EVALUATION

Technical Feasibility

Widely used.
Desal technology is widely used.

Legal Feasibility

Yes, but some ambiguities.
Water sharing agreement would need to be worked out with SqCWD; assumes facilities (pump stations, pipes, wells, etc.) would be located

City of Santa Cruz Water Supply Advisory Committee
Solutions Phase -- Technical Summary

Consolidated Alternative 15 - Desalination using Reverse Osmosis

Regulatory Feasibility
Very slow, no regulatory change.
Assumes that considerable time to complete the environmental and regulatory process will be needed.

Political Feasibility
Active resistance now.
Based on response to SCWD2 desal project, it is assumed there will be resistance but this may be overcome.

Regional Water Benefits
2 jurisdictions
Directly would impact SqCWD and SCWD.

Local Economy
Positive local.
Assumes a more stable water supply impacting a larger portion of the county will have a positive impact.

Energy
5
Desal facilities require considerable amounts of energy; pumping system will also require energy for this distance.

Marine Ecosystem Health
May harm.
Some negative impact is assumed.

Freshwater and Riparian Health
About as it is now.
Assume this ecosystem will not be modified since this alternative only fills the shortfall and does not reduce current diversions.

Terrestrial Resources
TBD
Scale for this criterion has not been developed

Environmental Profile
The environmental profile of this portfolio is acceptable with appropriate and effective mitigation.
Assumes impacts would exist but could be mitigated.

Groundwater Resources
Allows restoration.
Assumes water City does not take during wet years could be used by SqCWD and the City for GW restoration.

City of Santa Cruz Water Supply Advisory Committee
Solutions Phase -- Technical Summary

Consolidated Alternative 15 - Desalination using Reverse Osmosis

Infrastructure Resilience
Meets most challenges well.
Assumes new infrastructure would be built to meet codes/regulations but prolonged power outages could impact system.

Supply Reliability
Makes system significantly more reliable.
Diversifies water supply portfolio with additional source not dependent on weather.

Scalability
Can scale up ~650MG.
Alternative notes 500MG but assumes this could be increased or decreased and is the range.

Preserves Future Choices
Somewhat increases choice.
Assumes City could take desal water in wet or average years to reduce diversions if agreements written with this flexibility.

Yield
500-1000 MG

Operational Flexibility
Greatly increases .
Does not rely on existing facilities to provide all water.

Addresses Peak Season Demand
Yes

Implementability
Could be implemented with some challenges.
Requires overcoming environmental, interagency, community resistance hurdles.

Supply Diversity
Portfolio greatly increases the diversity of Santa Cruz's supply portfolio.
Adds additional source that is drought proof than current portfolio

Sustainability
This portfolio is somewhat sustainable.
Assumes aspects of desal (high energy, brine) are not "sustainable" but overall system is sustainable.

Issues to Resolve