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LOS ANGELES RECYCLED WATER IN CONCRETE MIXING
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A Special Thanks!

ENGINEERING
CITY OF LOS ANGELES

STANDARDS DIVISION
DEPARTMENT OF GENERAL SERVICES
SM

Irvine Ranch
Water District

CITY LA DBS
DEPARTMENT OF BUILDING AND SAFETY

Caltrans

DSA
DIVISION OF THE STATE ARCHITECT

CALCIMA
California Construction and Industrial Materials Association

SANITATION DISTRICTS OF LOS ANGELES COUNTY

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Relating All Waters

Understanding the relationships, connections and impacts of water projects, programs, policies and decisions

- Drinking Water
- Rain/Stormwater
- Groundwater
- Recycled Water
- Wastewater

Focus Meetings: Department and Regional Entity Discussions

" We are building a concrete batch plant" *… and it is only 100 ft away from an existing RW line* (Dec 2014)

"Code allows it so there is really nothing else you need to do"

"All you need is a letter from the State Water Resources Control Board to LA's Department of Building & Safety"

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RW Approach: Feasibility, Buy-in, Implementation

- Determine WQ @ WRPs
- Verify Codes, Policies, Regulations
- Survey Water Agencies
- Interview managers @ concrete mixing plants
- Determine road blocks - & fix

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DEPARTMENT OF GENERAL SERVICES

environment LA SANITATION
CITY OF LOS ANGELES

All departments were open, but were not convinced – yet – that it was viable

Recycled Water Uses For Concrete

Recycled Water Uses Allowed In California (Title22)				
Use of Recycled Water	**Treatment Level**			
	Disinfected Tertiary Recycled Water	**Disinfected Secondary 2.2 Recycled Water**	**Disinfected Secondary 23 Recycled Water**	**Undisinfected Secondary Recycled Water**
Mixing Concrete	**Allowed**	**Allowed**	**Allowed**	**Not Allowed**

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Recycled Water And Concrete Regulations

- **California Department of Health and Services**

Title 22, Chapter 4, of the California Code of Regulations

- **ASTM/ ACI allows RW in concrete**

RW was used in the 1990's by the City of LA (archived letter found by original Consulting engineer)

- **California Water Code Section** 13550-13556 states:

Industrial user cannot use potable water if recycled water is

- Available
- Provides sufficient quality for the uses required for the industry
- Is priced appropriately

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Concrete Regulations and Specifications

ASTM 1602/ ACI/ Greenbook

	ACI/ASTM 1602	GreenBook
	Limits, ppm	
Chloride as Cl^-		
Reinforced	-	1,000
non-reinforced	-	-
pre-stressed	500	650
other reinforced concrete	1,000	
Sulfate as SO_4		
reinforced	3,000	1,000
Pre-stressed	3,000	800
non-reinforced	3,000	-
Alkalies as (Na_2O + 0.658 K_2O)		
Max concentration in combined water	600	-
Total solids by mass		
Max concentration in combined water	50,000	50,000

Caltrans

	Caltrans
	Limits, ppm
Chloride as Cl-	
Reinforced	1,000
non-reinforced	2,000
pre-stressed	650
other reinforced concrete	-
Sulfate as SO4	
reinforced,	1,300
Pre-stressed	1,300
non-reinforced	1,500
Alkalies as (Na2O + 0.658 K_2O)	
Max concentration in combined water	300
Total solids by mass	
Max concentration in combined water	-

Average Wastewater Treatment Plant's Water Quality Data Comparison (Average)

	ACI/ ASTM 1602	GreenBook	Caltrans	RW Water Quality					
				DCT	LAG	TI	WB-Tertiary	WB-Feedwater	Hyperion
	Limits, ppm			**Average** (mg/L)					
Chloride as Cl^-									
reinforced	-	1,000	1,000	153	150	83	395	7	313
non-reinforced	-	-	2,000						
prestressed	500	650	650						
other reinforced concrete	1,000	-	-						
Sulfate as SO_4									
reinforced,	3,000	1,000	1,300	124	124	142	154	ND	169
prestressed	3,000	800	1,300						
non-reinforced	-	-	1,500						
Alkalies as (Na_2O + 0.658 K_2O)									
Max concentration in combined water	600	-	**300**	216	219	69	**356**	14	**357**
Total solids by mass									
Max concentration in combined water	50,000	50,000	-	627	760	181	1,088	19	1,012

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Average Wastewater Treatment Plant's Water Quality Data Comparison (Maximum)

	ACI/ ASTM 1602	GreenBook	Caltrans	RW Water Quality					
				DCT	LAG	TI	WB-Tertiary	WB-Feedwater	Hyperion
	Limits, ppm			**Maximum** (mg/L)					
Chloride as Cl^-									
reinforced	-	1,000	1,000	162	157	97.3	431	7.35	333
non-reinforced	-	-	2,000						
prestressed	500	650	650						
other reinforced concrete	1,000	-	-						
Sulfate as SO_4									
reinforced,	3,000	1,000	1,300	177	188	1.62	162	ND	191
prestressed	3,000	800	1,300						
non-reinforced	3,000	-	1,500						
Alkalies as (Na_2O + 0.658 K_2O)									
Max concentration in combined water	600	-	**300**	224	229	75.8	**372**	16.1	**393**
Total solids by mass									
Max concentration in combined water	50,000	50,000	-	652	794	229	1160	23	1070

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Manufacturer Outreach: Concrete Mixing Plants Within City Boundaries

- Did not return emails, phone messages, etc.
- Spoke with Irvine Ranch Water District & Sanitation Districts of LA County (Robertson's)
- Called the National Concrete Association in DC
- Followed up with California Construction and Industrial Materials Association (CalCIMA)'s Director
- Robertson's would hook up every concrete plant if RW was available by their property

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Conference Call With 5 Regional Concrete Suppliers: **Key Outcomes**

- ***Industry Standard Terminology-*** In the concrete production industry, the term Recycled Water is interchanged with Recirculated Water.
- ***Design Specifications-*** "Potable" vs. "ASTM c1602 compliant water"
- ***Variations in project specifications-*** if the concrete specifications state "potable water", then the suppliers are currently required to use potable water.
- ***Liability-***
  - Many commercial project specifications , written by developers' engineers, or other design teams, almost always require "potable water", rather than "ASTM 1602 compliant water" (RW).
  - Suppliers believed potable water is required because structural engineers know that those in the concrete industry interchange on a regular basis*: Recirculated Water is interchanged regularly for Recycled Water*
  - If an issue with the concrete were to occur, the perception is that the customer will easily target the use of RW as a problem. Potable water is used as a default to avoid any liability.
  - Should anyone be concerned using RW in special mixes- (mixes that require specific admixtures, temperature, color, etc.)?
- ***Additional Cost*** – Using water that is non- potable (RW, recirculated water, etc.) could require additional testing by the concrete batch plant. This takes additional time and effort. This needs to be clarified – does WRP samples taken cover them?

Progress!

City of LA- Bureau of Engineering Specifications

Specifications Changes- Encouraging the use of Recycled Water **:**

1. **Section 03300- Cast in Place Concrete, Article 2.1.D.5**
2. **Section 03310- Cast-In-Place Concrete, Article 2.8.D.3**
3. **Section 03314 -Surface Cleaning & Preparation, Article 2.01.A**

City of Los Angeles Recycled Water Effluent Testing

Additional Testing- regular testing for Alkalis at the following Reclamation Plants:

- Donald C. Tillman Water Reclamation Plant (DCT) (tertiary)
- Los Angeles / Glendale Water Reclamation Plant (LAG) (tertiary)
- Terminal Island Water Reclamation Plant (TI) (advanced treatment)

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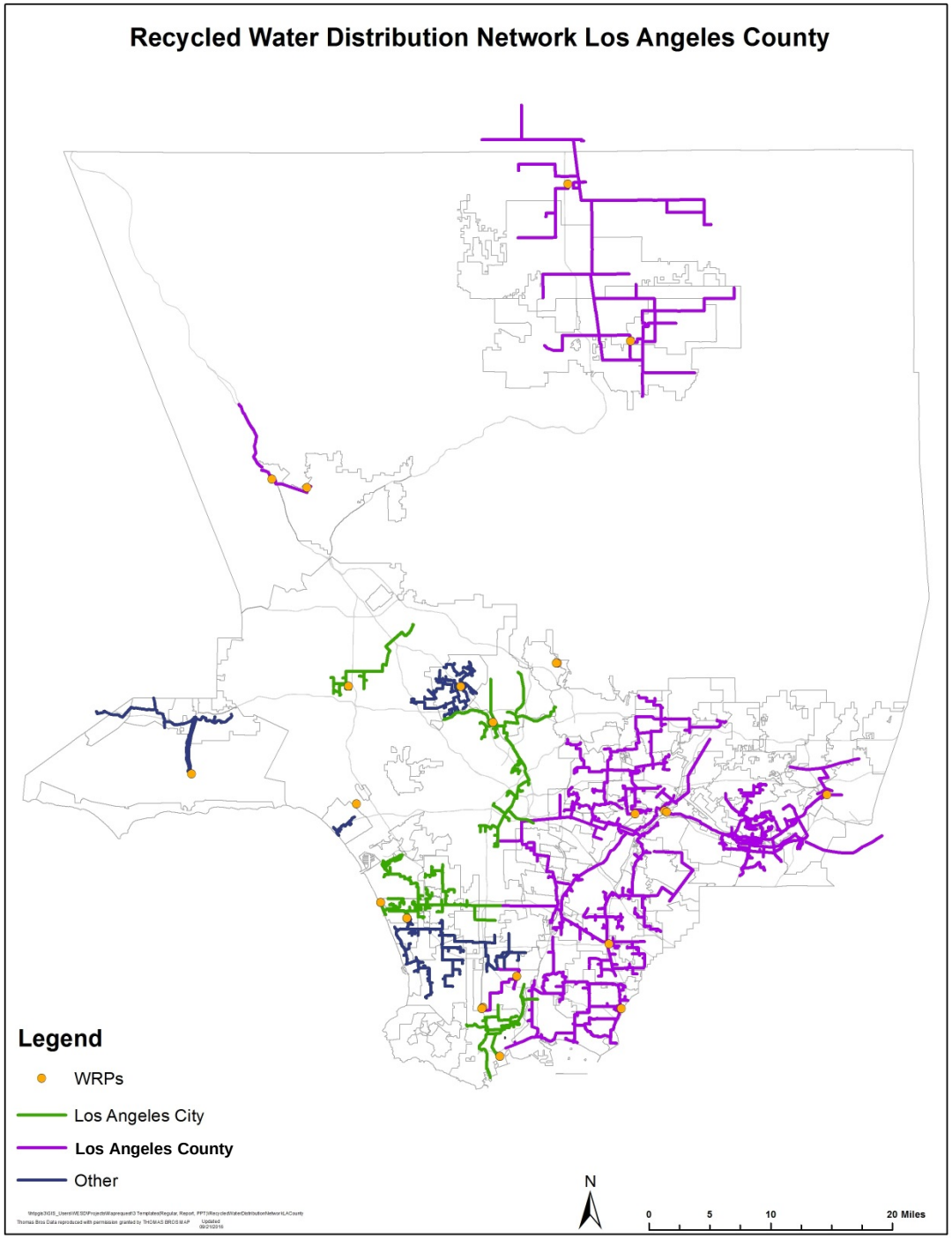
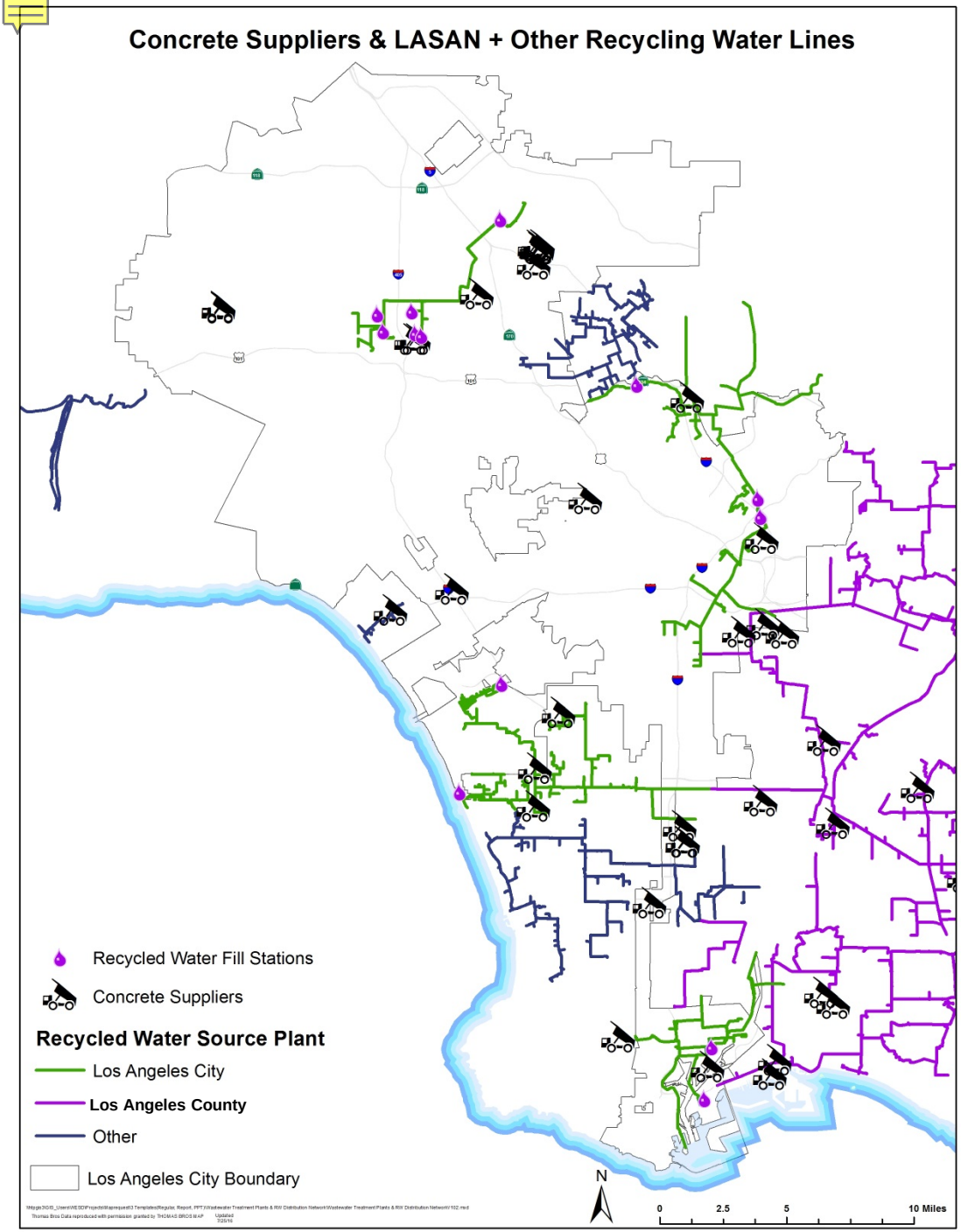


Los Angeles' Regional Recycled Water Distribution Network

City of LA Region: Potential Opportunities



25 concrete suppliers within a 5 mile distance to a recycled water pipeline. (approx. 20 miles of pipeline needed to connect)

- City of LA Connection Cost: $13.6 M (green)
- Other Water Agency Connection Cost: $6.15 M

If all 40 City of LA region concrete suppliers connect and only use RW:

- Up to 1.2 Billion gallons/year (3541 ac-ft/yr) of potable water would be saved (170 gal / Cu yd).

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Recommended Next Steps

- **Work with Department of Consumer Affairs to distribute the information to all Engineers and Architechs so that specifications are not written requiring potable water.**
- **Educate City staff, both field and office, as well as contractors, and construction workers about the safety of recycled water (RW).**
  - Develop a RW user manual whose audience can vary, but includes public and private entities
  - Incorporate WateReuse Association and other Professional Organization's materials
- Determine if additional language needs to be written in policies or if legislative action is required for liability purposes so that contractors & manufacturers can use RW in concrete.
  - Work with CalCIMA and their members for educational purposes
  - **Identify what it will take to <u>require</u> RW in concrete for ALL City/County/State contracts (or if even possible)**
  - Reach out to other public entities about RW opportunities in concrete

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Next Steps Continued

- **Understand how to make sure Structural Engineers, both private and public, cannot choose potable water over RW, if RW is available in adequate quantity and meets specified quality.**
- **Change "potable" to "ASTM 1602 compliant" in all design specifications (see City of LA's BOE revised concrete specifications).**
- Identify funding opportunities to connect concrete suppliers to a RW source (connecting plants to RW networks) that meets ASTM, GreenBook and Caltrans water quality requirements.
- Identify previous concrete performance testing studies (Caltrans) to improve the perception of RW use for concrete production.
- Include the use of RW for concrete mixing in all nominal building requirements highlighted in the California Building Code.
- Determine if there is a need to identify RW in concrete during city inspections.
- Reach out to U.S Green Building Council to implement RW use for concrete production as a part of LEED Certification.
- Determine if extra 'points' are to be given to construction bids with RW in concrete
- Work with Regional entities, such as Metro, High Speed Rail, MWD, etc., to determine if their specifications currently state "ATSM 1602 compliant" or "potable water must be used" in their concrete mix. If specifications state "potable water", determine how the specifications can be changed to "ASTM 1602 compliant".
- **Determine how to address commercial and private entities whose structural engineer prefers potable water over "ASTM 1602 complaint" when writing concrete specifications.**

ANY QUESTIONS?

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Water Savings

Example of Annual Water Benefits

Region	Concrete Produced (Million m^3)		Potential Potable Water Saved (Million L)[1]		Min. Annual Savings to Concrete Industry due to using RW instead of Potable[3,4]	
	2014	2015	2014	2015	2014	2015
Los Angeles	3.67	5.19	3,088	4,368	$751,264	$1,062,422
Southern California	9.83	12.5	8,269	10,512	$2,011,195	$2,556,792

Notes:
[1]170 gallons per 1 yd^3 of concrete produced (Silvia and Naik, 2010) is the same as 643.5 Liters of water used per 0.765 m^3
[2]Assumes all concrete mixing, in Los Angeles and Southern California, is done using RW (12.9 M cu yd)
[3]Assumes $1,000/acre-foot. (There are 1,233,000 L/acre-foot)
[4]An assumed 30% cost savings is presented – this can vary

Concrete Produced in Southern California (Million m^3):

2014 Data

Los Angeles – 3.67 m^3(4.8 yd^3)
San Bernardino – 1.45 m^3 (1.9 yd^3)
Riverside – 1.38 m^3 (1.8 yd^3)
Orange – 1.30 m^3 (1.7 yd^3)
San Diego – 1.61 m^3 (2.1 yd^3)
Santa Barbara/Ventura – 0.38 m^3 (0.5 yd^3)
Imperial – 0.038 m^3 (0.05 yd^3)

2015 Data

Los Angeles – 5.2 m^3(6.8 yd^3)
San Bernardino – 2.14 m^3 (2.8 yd^3)
Riverside – 1.45 m^3 (1.9 yd^3)
Orange – 1.68m^3 (2.2 yd^3)
San Diego – 1.45m^3 (1.9 yd^3)
Santa Barbara/Ventura – 0.54 m^3 (0.7 yd^3)
Imperial – 0.077 m^3 (0.1yd^3)

Source: California Construction and Industrial Materials Association (CalCIMA)

Additional Comments

- Concrete suppliers were willing to switch to RW if all specifications related to concrete, not just from public entities, allowed RW in the concrete mixes.
- Structural engineers wield a lot of power
- Suppliers want a guarantee that a Structural Engineer could not require potable water over RW if water quality standards are met. The concern was if they had to have two water systems at the concrete plant, such retrofit would not be cost effective.
- All plants in the LA City or region need to switch to RW (90 minute delivery time to site)
- The concrete industry's very limited usage of RW has some owners wary
- Since there is only one Ready Mix supplier using recycled water (Robertson), The City of Los Angeles cannot currently mandate the use of RW as that would suggest the City is indirectly sole-sourcing concrete from one supplier.

Figure: RW signage at the Robertson's Irvine location (courtesy of IRWD)

Structural Engineering Authority

Structural Engineering Authority Reference Documents						
No.	Reference Document	Section	Statement	Issue Addressed	Source	
					Link	Page No.
1	Professional Engineer's Act					
		Chp. 7 Professional Engineers Article 3. Application of Chapter (6731)	*Civil engineering embraces the following studies or activities....(a)The economics of, the use and design of, materials of construction and the determination of their physical qualities (b)The preparation or submission of designs, plans and specifications and engineering reports.*	Structural Engineer has the authority to prepare the specifications of the design. The specifications include the type of materials used for construction (type of water).	Click here to view document	8
2	Board Rules and Regulations Relating to the Practices of Professional Engineering and Professional Land Surveying					
		California Code of Regulations. Title 16, Division 5. §§ 400-476. Article 1: General Provisions (404.1. Responsible Charge: Professional Engineering.)	*(2) Engineering Decisions. Engineering decisions which must be made by and are the responsibility of the engineer in responsible charge are those decisions concerning permanent or temporary projects which could create a hazard to life, health, property, or public welfare, and may include, but are not limited to:(b) The selection or development of design standards or methods, and materials to be used.*	Structural Engineer has the authority to prepare the specifications of the design. The specifications include the type of materials used for construction (type of water).	Click here to view document	6
		California Code of Regulations. Title 16, Division 5. §§ 400-476. Article 1: General Provisions (415. Practice within Area of Competence.)	*A professional engineer or land surveyor licensed under the Code shall practice and perform engineering or land surveying work only in the field or fields in which he/she is by education and/or experience fully competent and proficiency*	Only a Structural Engineer's can make the decision of choosing potable water over Municipal Recycled Water in concrete mixing.	Click here to view document	12
3	Code of Ethics for Engineers					
		Section II: Rules of Practice	*Engineers shall perform services only in the areas of their competence.* *a. Engineers shall undertake assignments only when qualified by education or experience in the specific technical fields involved.*	Only a Structural Engineer's can make the decision of choosing potable water over Municipal Recycled Water in concrete mixing.	Click here to view document	1

Specification Changes:

City of LA- Bureau of Engineering Specifications

Specifications:

1. **Section 03300 Cast in Place Concrete [long form], Article 2.1.D.5:**
   a. *Notice To Specifier: For Municipal Facilities Projects - recycled water is an acceptable alternative to potable water. While different levels of recycled water purity exists, depending on the intended end use, the Building Code and various other standards have for some time now published acceptable thresholds under which it can be used for constructing concrete facilities.*
   "Water for mixing shall conform to ASTM C 1602 and be clean and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities. The use of qualifying recycled water is encouraged."

   b. *Notice To Specifier: All Others using SSPWC – recycled water is an acceptable alternative to potable water. For some time now, the Standard Specifications For Public Works Construction (SSPWC) has published the purity thresholds that recycled water must meet under which public works concrete structures can be constructed. These limits meet or exceed those of ASTM C 1602.*
   "Water for mixing shall conform to the SSPWC, Section 201-1.2.3, "Water". The use of qualifying recycled water is encouraged."

Specification Changes (Cont.)

City of LA- Bureau of Engineering

Specifications:

2. Section 03310 Cast-In-Place Concrete [short form], Article 2.8.D.3:

a. *Notice To Specifier: Recycled water is an acceptable alternative to potable water. While different levels of recycled water purity exists, depending on the intended end use, the Building Code and various other standards have for some time now published acceptable thresholds under which it can be used for constructing concrete facilities.*

"Water for mixing shall conform to ASTM C 1602 and be clean and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities. The use of qualifying recycled water is encouraged."

3.Section 03314 Surface Cleaning & Preparation, Article 2.01.A:

Notice To Specifier: All Others using SSPWC – recycled water is an acceptable alternative to potable water. For some time now, the Standard Specifications For Public Works Construction (SSPWC) has published the purity thresholds that recycled water must meet under which public works concrete structures can be constructed.

Specification Changes (Cont.)

City of LA- Bureau of Engineering

Specifications:

3.Section 03314 Surface Cleaning & Preparation, Article 2.01.A (Cont.):

Notice To Specifier: All Others using SSPWC – recycled water is an acceptable alternative to potable water. For some time now, the Standard Specifications For Public Works Construction (SSPWC) has published the purity thresholds that recycled water must meet under which public works concrete structures can be constructed. These limits meet or exceed those of ASTM C 1602. Since the primary use of the water under this Section is intended to clean the inner surface of an existing sewer, more generous thresholds should be considered.

"Water: Water for mixing shall conform to the SSPWC, Section 201-1.2.3, “Water”. The use of recycled water is strongly encouraged."