To the Professional Engineers in California Government:

I am truly honored to have received the Marilyn Jorgensen Reece award this year from your organization at the 68th annual Los Angeles County Science Fair. As California's first registered female civil engineer, Marilyn revolutionized her state's infrastructure and paved the way for millions of young girls in her field- as a young engineer myself, I aspire to do the same. This award means a lot to me, and I view it as a wonderful opportunity to expand upon my project and to grow as an engineer.

My project began when I was in 8th grade, with a road trip to Northern California in late September of 2015. It was notorious for being the worst year in California's long drought, and the water shortages' disastrous effects became evident when passing through Bakersfield and the rest of California's farming districts. I knew that the state had enacted many water conservation programs and placed restrictions on residents of certain counties, yet nothing seemed to be working at the time. This inspired me to do extensive research, through which I learnt:

- Toilets make up 11.2% - 12.7% of an average household's daily water usage (a lot for just one fixture),
- The state of California strongly urges people to replace their current toilet tanks (mostly 1.6 GPF, or Gallons per Flush) with dual modes and HETs (high efficiency toilet tanks).
- Dual modes have a normal 1.6 GPF mode and another half-flush/water efficient 0.8 GPF mode while HETs just use 0.8 GPF. Both cost anywhere between $150-$500 and take some time to install, and 0.8 GPF often causes plumbing issues (which became a problem for San Francisco in recent years).
- Dual modes average at 1.28 GPF throughout the day.

After gathering this information, it became obvious that a cheaper, more efficient solution was needed. Eventually, after designing many prototypes, I invented a simple working device that can be retrofitted into a 1.6 GPF toilet tank and convert it into a dual mode using a 48 ounce bottle with a hole at the bottom. This creates a vacuum when flushing which holds up an average of 0.26 gallons per flush (when the cap at the top is closed). This prototype along with its predecessor were presented at the 66th LA County Science Fair, from where it advanced to California State Science Fair and Broadcom National Science Fair. However, I was unsatisfied with the model, as my goal was to create a dual-mode device with a water-efficient mode of 1.28 GPF rather than 1.34 GPF. The "suction bottle" device was also unreliable and produced inconsistent data due to a significant and varying water level drop within the device when flushing. This was a result of the device's walls being thin and thus easily overcome by the strong flushing force along with a leaky cap which needed to be fluid tight when closed.

I continued thinking of solutions to these issues throughout my freshman year of high school. I eventually built a completely new design which I wished to enter in LA County Science Fair as a continuing project; I also wished to introduce more high school students to science fairs and local STEM opportunities. These goals inspired me to start my own club in my sophomore year to guide students through experimentation and project-making processes and to organize Granada Hills Charter High School's first annual Science Fair & STEM Expo, which took place in January of this year. My latest prototype, now featuring a one-way valve, open-close valve, and a handle (to hook onto the toilet tank wall) competed at the school science fair and made it to LA County Science Fair. This new design produces consistent results due to its fluid tight one-way valve and is very user-friendly. A windshield

washer reservoir with an open bottom was used as the device's holding tank, and a water flask (with its sides cut off) was used as the device's handle. With all the parts combined, the total cost to produce this model was $30.08 – nearly one tenth of the retail and installation cost of an average dual-mode toilet tank. To retrofit an old 1.6 GPF tank, a user must simply remove the toilet tank lid and hook the device onto the side of the toilet tank. For a water efficient mode, the open-close valve (on the outside of the tank) would be rotated 90^{o} clockwise (until it cannot rotate anymore), and for a normal 1.6 GPF mode, the open-close valve knob would be left in a vertical position. After running multiple trials of two tests, a visual experiment measuring the water level inside the device and another timing the toilet bowl's refill rate with and without the device, it was found that this device consistently saves 0.25 GPF and 13 seconds of bowl refill time. However, the device can easily be expanded (if a bigger holding tank is found) and the handle can be extended so that it is further submerged in water, meaning it can also save 0.32 GPF or more.

If only 10% of toilets in the city of Los Angeles were to be retrofitted with this device, it could save us about 900,000 gallons of water daily. I hope this device becomes a staple in every household currently without a dual mode toilet tank, saving the city, and even the state, millions of gallons daily.

I would like to thank Caltrans and the Professional Engineers in California Government for recognizing and honoring my work; three years of designing and redesigning this dynamic product were truly worth it. A special thank you to Mr. Vassiliades, who took time to understand my project, saw potential in this device, and gave me the honor of being a recipient of the 2018 Marilyn Jorgensen Reece award. I am thrilled by the opportunity to present my project at the upcoming ceremony and look forward to discussing its future with state officials.

Sincerely,

Megha Jain