January 18, 2010

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Project Proposal for a total spa system

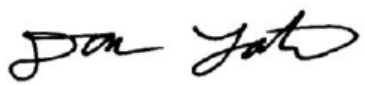
Dear Dr. Rawicz,

Attached is a copy of our project proposal for the *Spa Commander*, This document discusses our planned project outline and other important information pertaining to the ENSC 440 -Capstone Engineering Science Project. Our goal is to design an affordable and portable water solution for Spa owners to use in the comforts of their own homes. This spa system will allow users to easily check the cleanliness and safety of the water before enjoying a dip, without the hassle of handling messy chemicals and doing tricky mathematical equations on the fly.

In our proposal we will detail our design, proposed solution, project scheduling, a tentative budget and possible funds, as well as company and team profile. Our company, Aquamatic Technologies Ltd. consists of five senior undergraduate engineering students- Matt Bergsma, Ken Chou, Dan Latuszek, Michelle Ochitwa and Sulien Wong.

If after persuing the proposal, you have any questions, comments or concerns, please contact Matt Bergsma – our company contact – at his email address (mjb4@sfu.ca)

Sincerely,



the Aquamatic Team

Enclosure: Project Proposal for our *Spa Commander*

Proposal for our Spa Commander

Revision: 1.1

January 18, 2010

Project Team:

Matt Bergsma

Ken Chou

Dan Latuszek

Michelle Ochitwa

Sulien Wong

Contact:

Matt Bergsma at mjb4@sfu.ca

Submitted To:

Dr. Andrew Rawicz – ENSC 440

Steve Whitmore – ENSC 305

School of Engineering Science

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Executive Summary

For swimming pool and spa owners, maintaining proper pH and chlorine concentration can be a frustrating chore often reliant on guessing and testing. Proper chlorination and pH is essential in inhibiting the growth of bacteria while preventing unnecessary skin and eye irritation. Nevertheless, there are very few viable automatic calibration systems on the market for home use from both a cost and implementation perspective. These systems are typically designed for larger pools and permanently fixed to the filter, and the average consumer will often require professional installation resulting in high initial installment, maintenance, and replacement costs.

In the United States, there are over 5 million existing in-ground pools and 3.5 million above-ground pools. Combined annual sales of in-ground and above-ground pools in the United States amount to over 300,000. In Canada, there are over 7,000 pool construction permits issued in urban centres alone and over 650,000 existing pools. On the hot tub and spa market, there are over 6.6 million existing hot tubs in the United States and over 450,000 existing hot tubs in Canada with annual sales of approximately 300,000 and 30,000 units in each country respectively. Aquamatic has identified this potential market and are proposing to design a portable system that automatically and accurately calibrates pH and chlorine concentration – the Spa Commander.

The Spa Commander's appeal to consumers will lie in its portability as it will also translate to easy installment, removing the need for professional installation, reducing its cost of ownership over permanent solutions. The Spa Commander will be designed so that it is easy to use, requiring owners to refill chemicals and input some key specifications of the pool. The Spa Commander will also provide customers with peace of mind knowing that proper pH and chlorine concentration is constantly maintained.

The cost of development and testing of the Spa Commander is estimated at $600.00, which will be obtained from different sources as outlined in the "Budget" section of the following report.

The Aquamatic team is composed of 5 senior engineering undergraduate students with a wide range of experience and expertise in system design, digital systems, biomedical knowledge, and pool chemistry. Using the 13-week semester Aquamatic will implement the proposed design and reach our milestones as projected below.

Table of Contents

1. Introduction

Currently, many swimming pool and hot tub owners are required to perform regular and annoying manual pH and chlorine concentration. Many systems will also leave residue buildup over time that must be manually removed. Unfortunately for consumers, all the existing products on the market are expensive. The Spa Commander seeks to address the issue with an affordable and user-friendly product that removes the need for manual testing and provides peace of mind with a water quality indicator.

Once mounted to a pool, hot tub, or spa, the Spa Commander will indicate immediately whether the water is safe to enter. If the chemical levels need to be adjusted, the automated system will adjust the pH and chlorine levels to bring the levels in line to the appropriate values.

The portability of the Spa Commander allows the user to reduce its exposure to weather, ideal for owners of remote cabins with exterior hot tubs. The Spa Commander can be easily uninstalled by unplugging the AC power adaptor and draining the lines allowing owners to store the Spa Commander indoors during the winter, preventing the system from freezing and increasing the lifespan of the system. The Spa Commander can be easily reinstalled by plugging in power and dropping the lines back into the water. Immediately it will begin adjusting the pH and chlorine levels to safe values.

The Spa Commander also contains lights to indicate chemical levels and the specific chemicals that are running low. The Spa Commander also improves water quality integrated water softener to address water hardness and a filtering mechanism that removes litter from the water.

The Spa Commander is designed to automatically maintain the chemical balance within the recommended guideline specified for pools, spas, and hot tubs to alleviate the burden currently placed on owners.

2. System Overview

The flowchart below (Figure 2.1) outlines the operation of the Spa Commander. The system takes a continuous feed of water from the pool or hot tub through a filtering system. The water's chlorine level and pH is then measured so the system can add the proper chemicals to bring the pool chemistry in line with the appropriate values. The water with the newly added chemicals is then returned to the pool. If the pool's chemical balance is within acceptable bounds, a mechanism will indicate that the pool or hot tub is safe to use.

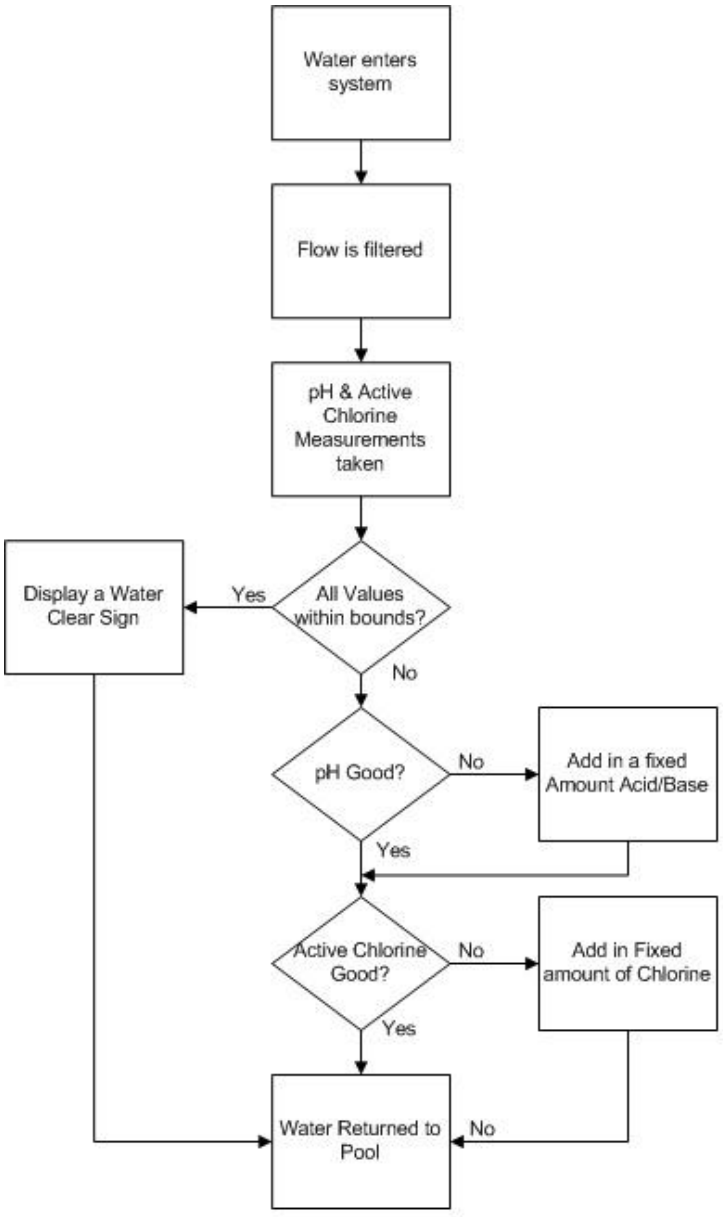

Figure-1: Flowchart of System

3. Possible Design Solutions

3.1 Permanent Mounted Complex Control System

The entire mechanism is designed to be permanently mounted into a pool system, with a complex MIMO PID controller, used to account for interactions between pH and Chlorine level, as well as letting the controller more rapidly bring the pool into balance and maintaining the balance of chemicals. A larger pump and filter will allow large circulation of the pool liquid as well as removal of floating debris that could otherwise affect performance of the device. As well pool condition logging, chemical usage, and a lcd display would be integrated into the system to allow the user to track any problems with the pool external to the cleaning system, as well as see detailed information about the current conditions in the pool.

3.2 Mobile Complex Control System

The mechanism is designed to be temporarily mounted to a pool or hot tub utilizing a MIMO PID controller to provide faster, more accurate control of the chemical levels in the pool; as well as, a LCD display and logging capabilities. This design would also include a more advanced filter like the permanent mounted system.

3.3 Permanent Mount Simple Control System

Very similar to 3.1 above, except that it would only implement 2 simple control loops, but would still provide basic logging, and display of pool conditions. Likely would be implemented with 2 PID or 2 On-Off control loops, rather than a single MIMO loop.

3.4 Mobile Simple Control System

A filter and chemical control system which would be designed to be temporarily mounted to a pool or hot tub to provide basic maintenance of pool chemistry and waste management. It would consist of a simple media filter to remove suspended junk, a simple on-off measured chemical control system, along with simple binary pool good/bad display, chemical levels (full/empty) and possibly a passive water softener to deal with scaling and other related issues with hard water.

4. Proposed Design

While all 4 possibilities offer the consumer different levels of control, due to currently existing consumer solutions, we have decided to go with design 3.4 – Mobile Simple Control System. The reasons for this will be the ability to provide a solution that will be cheap enough to the consumer to make it worth their while to purchase this device for use in temporary pools, or hot tubs.
The simple flow diagram for this solution will be akin to figure 2 below which shows the generalized block diagram of our system.

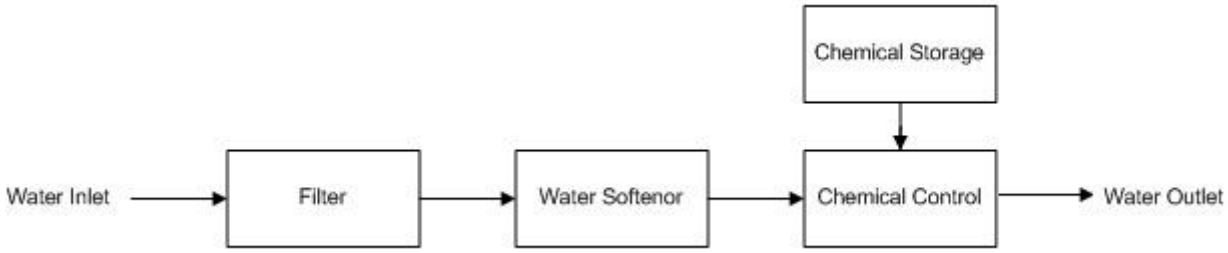

Figure -2: Block Diagram

The filter will be implemented via utilizing existing solutions, such as a simple media filter (gravel, or gravel and sand which the flow is forced through) as will be the water softener (a chemical in a container that the water will flow which will acidify the water slightly in exchange of removal of hardness causing chemicals). Both of which will not be included in the demo due to their proven field record, and since as far as our system is concerned will only act as pressure drops before our pump.
As for the important part the chemical control and storage blocks, the below diagram is a P&ID for the process.

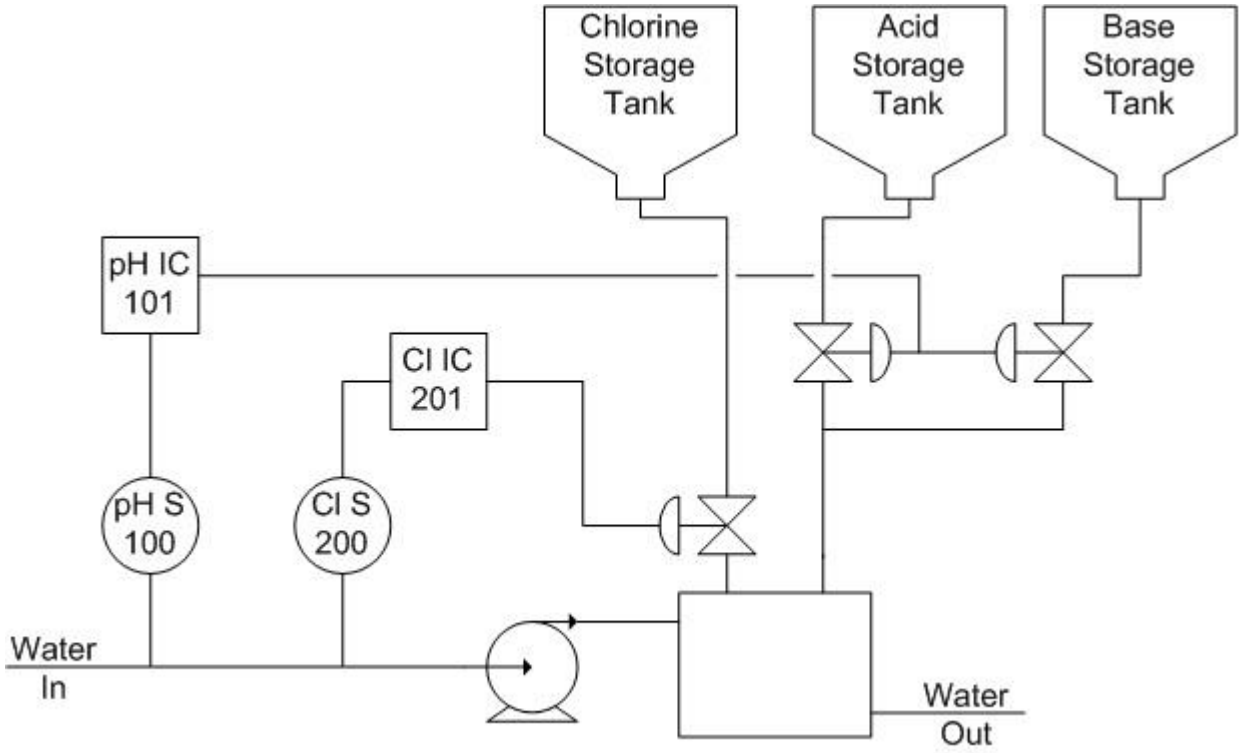

Figure -3: P&ID for Chemical Control

As for the actual control logic that will be implemented, for cost saving and simplicity reasons, it will be implemented in a On-Off control (eg. If level is to low add in a set amount of chemical) this will avoid the use of a more expensive micro-controller. The use of IC's and transistor level design will allow for a much more robust solution that will minimize power consumption. As well level in the chemical supply will be a simple full/empty style light, triggered by a mechanical switch.

5. Sources of Information

In order to complete this project, we will be acquiring information from a wide variety of sources which include data-sheets for spas and pools, course textbooks, friends and colleagues, the Internet, and faculty members and students at SFU.

The Internet will be a major source of information for technical specification of parts, functionality of the system, and prices of components. For example, websites from manufacturers and retailers of hot tubs and pools will provide us with valuable information on existing technology and solutions. Whereas discussion boards and patent databases will be sources of inspiration and insight for our own system.

We will also contact several hot tub and pool owners who are interested in lending us a hand with our project. Their knowledge on methods for proper hot tub and pool care would be beneficial to us and, if necessary they are willing to assist with product testing.

Furthermore, through our past school and work experiences we have made friends and colleagues whom we will be seeking additional help from. Their years of experience in the industry and knowledge of topics such as chemical analysis and control systems will be invaluable to our success.

6. Budget and Funding

6.1. Budget

A tentative budget outline for the project is listed in Table 1. A large sum of our costs will constitute of the pH and chlorine sensors, the pump and valve systems, and the large quantity of chemicals that will be used throughout the project. Most of the other equipment such as electrical parts and plumbing has not been finalized yet, so therefore some components have been grouped with other categories and anticipated costs have been overestimated by 15% to allow for contingencies.

Equipment	Price (CAD)
Pump	$250
Chlorine Sensor	$100
pH Sensor	$50
Thermometer	$10
Chemicals	$40
Gate valve	$40
Electrical components	$50
Plumbing	$50
Total Cost	$590

Table 1: Proposed Budget for the Spa Commander

6.2. Funding

One of the goals of our product is to be more affordable than current solutions that are commercially available. However, we expect the initial prototype to cost more than the finalized product, so therefore we have considered various sources of funding such as: the Engineering Science Student Endowment Fund and the Wighton Development Fund. We will also minimize costs by borrowing parts from old projects and other items that may be suitable to our product. Finally, we are prepared to share any costs left over after funding equally between the group members.

7. Schedule

Table 2 outlines our schedule for the major tasks associated with the proposed project. We hope to get much of the work done durning the Olympic break as you can see in the table below.

Task	Start Date	End Date	Total Days
Project Proposal	1/4/2010	1/18/2010	14
Functional Specification	1/18/2010	2/8/2010	21
Design Specification	2/8/2010	3/8/2010	28
Written Progress Report	3/9/2010	3/22/2010	13
Project Demo	4/12/2010	4/16/2010	4
Post-Mortem	4/12/2010	4/19/2010	7
Funding Application	1/4/2010	1/29/2010	25
Chlorine & pH Sensing	1/18/2010	2/12/2010	25
Chemical Dispensing	2/12/2010	3/15/2010	31
Logic Control / Display	2/24/2010	3/26/2010	30
Integration	3/15/2010	4/10/2010	26
Waterproof Casing / Filter	3/20/2010	4/5/2010	16
Prototype Testing	3/27/2010	4/16/2010	20
Olympic Break	2/12/2010	3/1/2010	17

Table 2: Scheduling of tasks

Table 3 is our Gantt chart. This shows the expected time each part of our project will take.

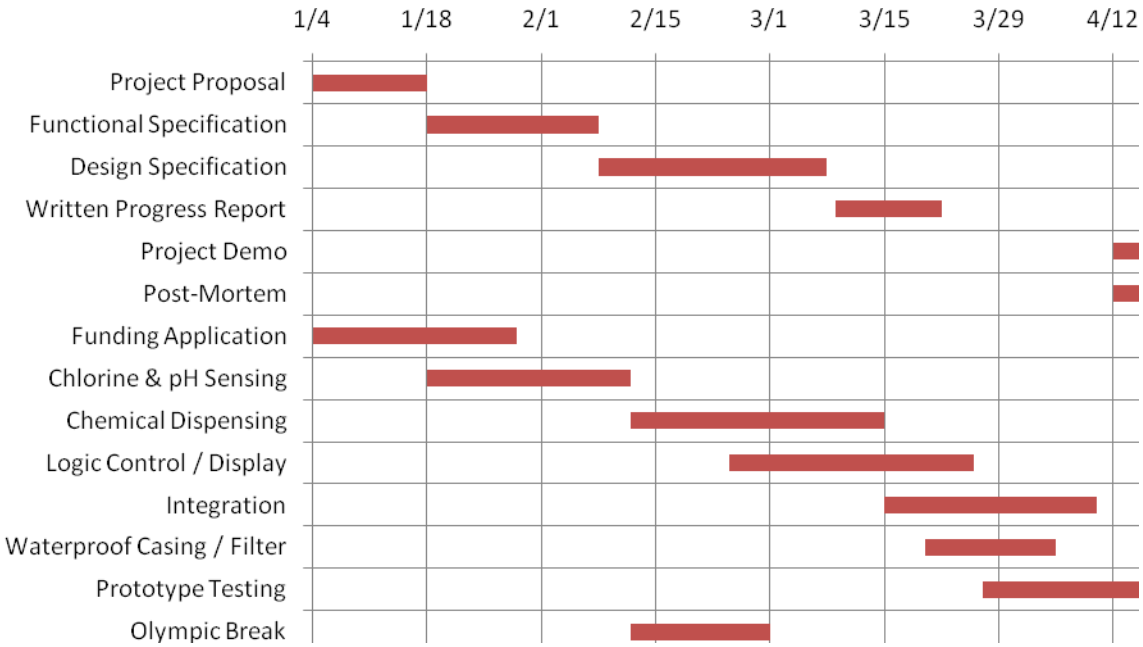

Table 3: Gantt Chart

Finally we have our Milestone table. This is a simple chart outlining the due dates for our documentation as relayed to us in ENSC 305, as we we have included our internal milestones that we are hoping to achieve by the dates shown.

Milestones

Documentation	
Project proposal	01/18/10
Functional specification	02/08/10
Design Specification	03/08/10
Written Progress Report	03/22/10
Post-Mortem	04/19/10
Development	
Chlorine and pH sensing	02/12/10
Chemical Dispensing	03/05/10
Logic control / display	03/19/10
Complete Prototype	04/05/10

Table 4: Milestones

8. Team Organization

Aquamatic Technologies Ltd. consists of five senior undergraduate engineering students- Matt Bergsma, Ken Chou, Dan Latuszek, Michelle Ochitwa and Sulien Wong. Each team member is nearing graduation (4th year students) and have varying specializations and interests.

All team mates have agreed to do an equal amount of work on our Spa Commander, and specifically work according to their own experience and expertise. Since the project is large, all five members will often need to collaborate on all aspects of the project, but we are aware some work must be delegated to specific persons as time is limited. This delegation will take into account our members strengths and weaknesses.

Using "Google Wave" we will post all communications and files to be shared online. This is our main mode of communication since our team members all have many responsibilities and differing schedules this semester. However we have agreed to meet at least once a week on campus (or otherwise) to discuss upcoming milestones and team issues. On such meetings Michelle Ochitwa will act as secretary and write a brief memo for the meeting minutes.

Aquamatic Tech. does not foresee any problems that would lead to conflict of interests or tensions in the team. We have all agreed, that in the case of differing opinions, we will go with the group opinion- or seek outside help. As such, each team mate will respect others opinions and make themselves heard as well.

9. Company Profile

Dan Latuszek – Chief Executive Officer (CEO)

Dan Latuszek is in his fourth and final year completing a BASc in systems engineering. He has had eight months of co-op experience; four of which were spent at KRP Communications Ltd where he had acquired electronics troubleshooting experience and management skills. He was responsible for ensuring that the production crew assembled and completed the power electronic products correctly and on time. In addition, Dan believes his interpersonal skills developed through his various customer service jobs and extra-curricular activities can benefit the team.

Sulien Wong – Chief Finance Officer (CFO)

Sulien Wong is currently in his last year of Systems Engineering at Simon Fraser University with co-op experience working with computer hardware, software, and networking. These experiences have helped him develop efficient working strategies and my attentiveness towards detail. Throughout his academic career and work experiences Sulien has also acquired a broad set of skills ranging from object oriented programming to electronic circuit and systems design.

Matt Bergsma, DipT – Chief Technical Officer (CTO) / Lead Designer

Matt Bergsma is a fourth year systems engineering student, with a Diploma of Technology in Chemical Sciences from BCIT. He has previous work experience at an industrial pump manufacturer (Toromont Process Systems) and more recently has completed an eight month co-op at Norpac Controls. His knowledge and skill set encompasses a large set gained via work experience, school and outside activities, but focuses around the design and implementation of control systems for chemi-mechanical processes.

Michelle Ochitwa – Vice President Operations (VPO) / acting Secretary

Michelle Ochitwa is a fourth year systems engineering student, with one year of co-op experience. She has worked for eight months in the manufacturing industry which will be an asset for our project's documentation as well as manufacturability. She has also been a lifeguard for the past six years and is very familiar with pool chemistry as a result. Michelle owns a hot tub bringing an asset to the team and providing a location for testing and developing the product.

Ken Chou – Chief Marketing Officer (CMO)

Ken Chou is a fourth year biomedical electronics student with a strong interest in digital systems design. He brings with him to Aquamatic testing methodologies acquired from his experience at Icron Technologies' Quality Assurance department. For this project he has undertaken the task of completing market research and competitive analysis.

10. Conclusion

Aquamatic Technologies' Spa Commander will save a consumer all the hassles of dealing with tricky chemical testing and messy chemicals. A user will not have to worry about maintaining the pool or hot tub or making sure it is safe for use. Once the removable product is mounted on the pool the automated system will adjust the chemicals and balance to pool for you. At a glance the swimmer will be able to see if the pool is safe to swim in.

This system is completely removable and easy to use. Worried about running out of chemicals? Once again a simple glance at our system, and you'll know whether or not more chemicals, and which ones are needed.

The Spa Commander will keep a consumers home pool or spa within the recommended guideline for chemical balance, and an integrated water softener and filter will remove any floating debris, and deal with any hardness in your water supply, all with minimal effort.

Sources and References

Equipment:
Thermometer ~$10 - http://www.dealextreme.com/details.dx/sku.15704

LEDs and electronic equipment– Radio Shack

Chlorine/bromine pellets – Michelle Ochitwa

Acid/base solution ~$20 - http://www.cedartubsdirect.com/chemicals-c-9.html (or Michelle Ochitwa)

Pump:
http://www.cedartubsdirect.com/index.php?main_page=index&cPath=4&gclid=CKO_3_vdqp8CFSMSagodTiRw0Q

Gate valve ~$40 -
http://www.spaguts.com/SpaParts.aspx?CMD=CATEGORY&CategoryID=11&CategoryText=Plumbing

pH Sensor $50-http://www.agile-fx.com/servlet/the-3068/Hanna-HI83141-Portable-pH-fdsh-mV-fdsh-Temperature/Detail

Cl Sensor $100:

http://www.rhtubs.com/ORP.htm

http://www.eutechinst.com/techtips/tech-tips27.htm

http://www.jumoplus.com/store/home.php?cat=422&gclid=CKP7ydv7p58CFQJaagodnG1H0g

http://www.eseasongear.com/orpmeter.html

Information:

Swimming pool market stats:
http://www.poolspamarketing.com

Patents:
http://www.patentstorm.us/patents/5326481/description.html
http://www.freepatentsonline.com/4016079.html

http://www.freepatentsonline.com/5326481.html

pool chemistry - http://uk.zodiac-poolcare.com/pool-water-treatment/pro-plus-g+ph-perfect-treatment29scenario1_5/pro-plus-g-and-ph-perfect-nature-2-mineral-water-purifier-and-chlorine-dispenser-and-automatic-ph-regulator.html