CANADIAN CONSULTING ENGINEERING AWARDS 2011

CANADIAN CONSULTING engineer

Water Reuse for Firefighting Training

CLIENT:
LAKELAND COLLEGE EMERGENCY TRAINING CENTRE

CONSULTANT:
ASSOCIATED ENGINEERING

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

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Water Reuse for Firefighting Training

Lakeland College Emergency Training Centre

PROJECT HIGHLIGHTS

Located about 200 kilometres east of Edmonton, Lakeland College in Vermilion, Alberta operates an Emergency Training Centre – the only facility of its kind in Western Canada. The Emergency Training Centre provides firefighting, emergency response, crisis control, and risk management training services to the public and private sectors. The facility uses elaborate props and sets up real-life firefighting scenarios using gasoline and propane as fuel for their training exercises.

The Lakeland College Emergency Training Centre draws make-up water from the Town of Vermilion's potable water distribution system to augment its fire training water demands, and discharges water into the town's sewer system.

The Challenge

Runoff water from the fire training exercises did not meet Alberta Environment's Surface Water Quality Guidelines and, therefore, could not be discharged to Vermilion River without further treatment. The College stored runoff water and sludge in the three ponds. Excessive sludge build-up prevented the College from extensively reusing the water in the fire training processes due to concerns of abrasion to their pumping equipment. The College trucked excess water offsite for disposal, a significant costs for the College.

Lakeland College wanted to treat and reuse water from the training process and reduce its reliance on the Town of Vermilion's potable water supply. The College engaged Associated Engineering to develop a cost-effective treatment process for treating the runoff for reuse or discharge to the environment.

The runoff water was a complex waste stream characterized by high turbidity and colour, suspended solids, polycyclic aromatic hydrocarbons (PAH), benzene, toluene, ethylbenzene, and xylene (BTEX) compounds, metals, nitrogen, and phosphorus. This unique mix of contaminants ruled out conventional water treatment processes. The challenge for the Associated Engineering team was to develop a robust, efficient, and cost-effective treatment process that could treat the wide range of contaminants and meet water quality requirements for reuse and discharge. In addition, Lakeland College wished to develop a facility that it could move, if necessary, should it decide to relocate the Training Centre. The facility also had to be easy to operate and accommodate future growth.

The Solution

To develop a solution, Associated Engineering developed a multi-stage approach comprising water quality analysis of the waste stream followed by bench-scale testing in a "laboratory" environment, and then on-site pilot testing using the actual waste stream to evaluate possible treatment options and confirm the design criteria. Design, construction, and implementation followed.

Bench-scale testing was conducted on traditional processes as well as a unique application of an existing product – Micro-Blaze Out® Emergency Liquid Spill Control, a proprietary foaming agent, which the Training Centre uses in firefighting training to extinguish gasoline-ignited fires. Micro-Blaze had biological treatment potential to remove hydrocarbons, but bench-scale testing showed that it increased the colour and nutrients in the treated effluent.

Following bench testing, we short-listed viable treatment options for on-site pilot testing. We also pilot tested additional treatment processes necessary for polishing water to the desired quality for environmental discharge. Pilot-scale testing confirmed a treatment process comprising **air stripping using packed tower aeration, clarification by coagulation-sedimentation, and dual-media filtration** to treat water for onsite water reuse, followed by **Granular Activated Carbon (GAC) adsorption** when discharge to the environment is required. The team recommended this operational philosophy to help the College minimize operating costs – by limiting use of GAC adsorption only as required for environmental discharge or for polishing to mitigate aesthetic concerns, the College would maximize the service life of the GAC media and limit replacement costs.

The technical excellence of the treatment process design is in the combination and application of existing technologies to effect the desired treatment. The recommended processes are proven and readily available from a number of manufacturers. As a result, costs would be competitive and operation would be streamlined.

Added Complexity

As Lakeland College was considering relocating the Emergency Training Centre, the College decided that it did not want to implement a full-scale, permanent facility – a cost of approximately $12 million. The College asked the team to design a smaller, temporary facility that could be moved and expanded. They established a $2 million budget for the smaller facility.

The team modified the design criteria for the water treatment plant to meet current demand, approximately 50% of ultimate capacity, and designed skid-mounted treatment units that could easily be relocated and expanded when necessary.

To meet the College's schedule, Associated Engineering recommended design-build delivery, which reduced the schedule by four to six months. Design-build delivery helped to meet the client's schedule and allowed the selected contractor to provide input to design, which helped to reduce cost.

Benefits & Achievements

The new water treatment facility allows the Lakeland College Emergency Training Centre to maximize water reuse, minimize reliance on make-up water from the Town of Vermilion, reduce operating costs related to hauling water offsite, minimize waste sent to the municipal sanitary sewer, and improve the quality of water discharged to the environment. Improving the water quality also reduces wear and tear on the fire training pumping equipment and mitigates odour arising from the fire training runoff water holding ponds. The Lakeland College Emergency Training Centre Water Treatment and Reuse Facility safeguards our water supply, the environment, and the ongoing operation of an educational facility that is an important part of the community and the Province of Alberta.

Water Reuse for Firefighting Training

Lakeland College Emergency Training Centre

FULL PROJECT DESCRIPTION

Introduction

Located in the Town of Vermilion, Alberta, Lakeland College Emergency Training Centre provides comprehensive emergency response, firefighting, crisis control, and risk management training services to the public and private sectors. The facility uses an elaborate series of props that burn gasoline and propane. Trainees are exposed to various, real-life, firefighting experiences in industrial and public settings in a safe, controlled environment.

Fire Training Activities

The Training Centre draws from the Town's potable water distribution system to augment its fire training water demands, and discharges excess Town's sewer system. Water quality analysis found that the typical fire-training runoff from industrial training activities contained high levels of turbidity, suspended solids, polycyclic aromatic hydrocarbons (PAH), benzene, toluene, ethylbenzene, and xylene (BTEX) compounds, some metals, nitrogen, and phosphorus. These constituents had to be removed before water could be reused or discharged to the environment.

Lakeland College retained Associated Engineering to complete a feasibility study and develop a cost-effective treatment process for treating the runoff. The College wished to maximize water reuse, minimize use of the Town's water supply, and minimize discharges to the environment or the Town's wastewater treatment plant.

Background

The Lakeland College Emergency Training Centre is the only facility in Western Canada that provides comprehensive emergency training for both public and private sector clients. The facility has earned a reputation for providing quality training using incredibly realistic training scenarios, which is imperative to prepare trainees to succeed during dangerous response situations. The facility is critical to growth and development of emergency responders throughout Alberta. The Texas Engineering Extension Service (TEEX), a member of the Texas A&M University System located in College Station Texas, is the only comparable facility in North America.

Fire Training Activities

Most of the site activities are related to fire-fighting exercises. Gasoline is used to create fire, which is extinguished by water mixed with a proprietary foaming agent, Micro-Blaze Out®. Some of the fuel is unburned and ends up in the waste stream.

Water used for firefighting is stored in holding ponds and is recycled for future exercises. The Town of Vermilion supplies make-up water for firefighting from its drinking water supply.

Pump Test Training

Discharges from the site include water used to extinguish fires during simulated fire suppression activities, as well as stormwater runoff. Water from the middle and western fire demonstration areas flows into a catch basin, which diverts the training runoff water to a stormwater sewer system, and then into three interconnected holding ponds. A portion of the fuel residues from the fire demonstration areas are removed by a three-compartment oil/water separator located in the middle of the site. Water in the holding ponds is recycled and pumped to the fire demonstration areas when required. Water and residue from the eastern fire demonstration areas drain into a dry ditch located at the northeast end of the facility. The final surface water discharge from holding ponds flows indirectly via the Town's storm sewer to the Vermilion River located approximately 7 kilometers northwest of the site. Appendix A contains an aerial photograph of the site.

The fire training runoff water does not meet Alberta Environment's Surface Water Quality Guidelines and, therefore, cannot be discharged directly into Vermilion River. Since the Training Centre cannot discharge to the Vermilion River, water and sludge accumulate in the three ponds. Excessive sludge build-up prevents reusing the water in the fire training processes due to concerns of abrasion of the pumping equipment. The Training Centre currently hauls excess water by truck to offsite disposal. This incurs significant costs, and, as a result, the Training Centre wanted to maximize reuse of the water from the fire training process.

The Challenge

The unique range of contaminants, turbidity, suspended solids, PAH and BTEX compounds, metals, nitrogen, and phosphorus, ruled out conventional water treatment processes. The team was challenged to develop an efficient and cost-effective treatment process that would meet water reuse requirements. In addition, Lakeland College wished to develop a facility that it could relocate, if necessary, should the College decide to relocate. The facility also had to be expandable to accommodate future growth.

The Approach

To address the unique water treatment challenge, Associated Engineering developed a scope of work that included initial feasibility study to assess the waste stream water quality, followed by preliminary

bench-scale testing (ie. in a laboratory environment) to evaluate a number of possible process treatment options. Bench-scale testing allowed the team to assess the treatability of the wastewater using a select number of possible treatment processes, and short-list viable treatment options. Following bench-scale tests, the team tested short-listed options in a pilot-scale facility located on site. Pilot-scale testing confirmed the treatment process using the actual waste stream and helped us to establish the design criteria. Following pilot scale testing, we completed design and oversaw construction.

Identifying Potential Treatment Options

Runoff Water Quality

To assess the runoff water quality, we collected surface water samples from the pump house adjacent to the holding ponds. Samples were analyzed for most of the parameters listed in Alberta Environment's Surface Water Quality Guidelines. Results of the analysis showed the following:

Degree of Difficulty: The team had to develop a unique treatment process that could treat a wide range of contaminants.

- **High turbidity and colour.** These might have originated from the suspended and dissolved solids and burnt hydrocarbons accumulated during the fire training exercises and surface runoff.
- **High concentrations of PAH and BTEX compounds.** The concentrations of these hydrocarbons were significantly higher than those reported in a previous water quality analysis. This difference in hydrocarbon concentration could be attributed to the number of times the water had been recycled (approximately 50 times).
- **High concentrations of some inorganic metals.** Some inorganic metals were found in concentrations higher than the water quality criteria. Metals could have originated from surface runoff, firefighting equipment, and/or the distribution system.

Preliminary Bench-Scale Tests

Upon analysis of the water quality results, we identified the following treatment processes for bench-scale testing:

- Coagulation
- Biological treatment
- Steam stripping
- Combined biological treatment and coagulation.

We collected runoff water samples for use in the bench-scale tests.

Coagulation Tests

Coagulation: Based on our site analysis of turbidity and colour and our experience with this type of treatment, we selected appropriate coagulation chemicals and chemical dosing. Coagulated water samples from the bench-scale jar tests were analyzed for PAH and BTEX. Coagulation trials were also carried out with water that was biologically treated and aerated.

Coagulation removed all the PAH compounds, but was relatively ineffective in removing BTEX compounds.

Biological Treatment: Biological treatment trials were conducted using the Micro-Blaze® Emergency Liquid Spill Control. Micro-Blaze® Emergency Liquid Spill Control contains a bacterial culture, which can digest hydrocarbons, converting them to carbon dioxide (CO_2) and water. The Micro-Blaze® Emergency Liquid Spill Control was mixed with the contaminated water and the water was incubated for five days at room temperature. Following incubation, the water was aerated for one day to release the volatiles and dissolved gasses.

New Application of Product:
Evaluating the Micro-Blaze Emergency Liquid Spill Control product as a potential treatment option was an innovative application of this product.

Biological treatment removed most of the PAH and BTEX compounds, but there was very little turbidity reduction. The application of Micro-Blaze® Emergency Liquid Spill Control for biological treatment resulted in increased level of colour and nutrients in the treated water.

Steam Stripping: Bench-scale steam stripping experiments were conducted by heating the contaminated water to just below the boiling point (90°C), followed by aeration for 5 minutes. Although this was not an exact simulation of conventional steam stripping where a packed column is used, it provided insight into the effectiveness of the steam stripping in volatilizing the dissolved hydrocarbon compounds.

Steam stripping alone removed the BTEX compounds, but the PAH removal was not as high as the coagulation or biological treatment processes. Bench testing demonstrated that applying steam or air stripping before the other treatment processes could provide good removal of the volatile compounds.

Biological Treatment and Coagulation: Combining biological treatment and coagulation achieved over 95% removal of the PAH and BTEX compounds and reduced turbidity as well. However, some of the PAH were always above the applicable criteria irrespective of the treatment process adopted.

Metals remained relatively unaffected by all the treatment processes except for iron, which was successfully removed by the combined treatment process.

The following table summarizes the results of bench-scale tests.

Parameter	Coagulation	Biological Treatment	Steam Stripping	Combined biological treatment and coagulation
Turbidity	✓	Increased		✓
Suspended Solids				
Colour	✓	Increased		✓
PAH	✓	✓		✓
BTEX		✓	✓	✓
Metals	✓			
Nitrogen	✓			✓
Phosphorus	✓			✓

Confirming Treatment Process

Bench-scale testing indicated high potential removal percentages of the contaminants; however, key contaminants remained too high for environmental discharge of the water. Based on our experience, we recommended on-site pilot testing of additional processes to evaluate alternate treatment and polishing options. Pilot testing and water quality fingerprinting of the training site runoff water would help to confirm and optimize the proposed treatment scheme. The pilot-testing program would allow a more accurate assessment of the fire training runoff water quality and quantity during live fire training operations. It also tested the proposed treatment process and established the optimum design criteria.

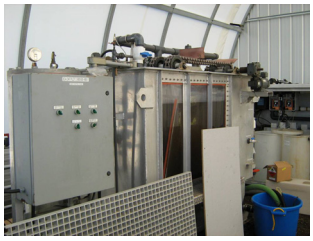
On-site pilot testing using the training site runoff water was conducted using the following treatment processes:

- Micro-Blaze® Treatment
- Air Stripping
- Conventional Clarification
- Dual-media (sand/anthracite) filter
- Dissolved Air Floatation
- Granular Activated Carbon Adsorption
- Advanced Oxidation by Ozone
- Biological Filtration.

Dissolved Air Flotation (DAF) and biological filtration had promise due to the nature of the contaminants. Advanced Oxidation and Granular Activated Carbon (GAC) were selected to provide polishing treatment.

As the Training Centre did not have existing facilities to house or support pilot process units, Associated Engineering coordinated installation of a temporary shelter, design and installation of pilot equipment, pilot operations, and water quality testing.


Pilot Testing


DAF Unit


Conventional Unit


GAC Unit

The pilot tests confirmed the treatability of the waste stream to levels required for reuse or direct discharge to a receiving water. The recommended treatment processes were as follows:

- Air stripping
- Clarification
- Dual-media filtration for onsite water reuse and
- GAC adsorption for environmental discharge.

Advancement of Technology: The team demonstrated the use of proven processes to treat a difficult waste stream.

Appendix B contains a process flow schematic.

The technical excellence of the treatment process design is in the combination and application of existing technologies to achieve the desired treated water quality. The recommended processes are proven and readily available from a number of manufacturers. As the treatment processes are proven and available, costs would be competitive and operation would be streamlined.

Technical Excellence: Through bench- and pilot-scale tests, the team identified a multi-stage treatment process that meets criteria for water reuse and discharge to a receiving water.

The team recommended managing operational costs by ongoing use of the air stripping, clarification, and dual-media filtration processes for on-site water reuse and limited use of GAC adsorption – ie. only when required for environmental discharge or polishing to mitigate aesthetic concerns. This will maximize the service life of the GAC media and limit replacement costs.

Implementation

With the treatment process confirmed, the team moved to the detailed design and construction stage of the project. While the Training Centre needed to implement treatment of fire-training runoff before the upcoming training season, Lakeland College was uncertain about implementing a full-scale permanent facility. The cost estimate for a full scale, permanent water treatment facility was approximately $12 million dollars. The College was contemplating possible relocation of the fire training facility in the future. As such, they were unwilling to invest in a permanent water treatment facility until the future training facility location was confirmed.

Water Reuse for Firefighting Training

Lakeland College Emergency Training Centre

The College wanted to implement a smaller temporary facility that could be moved and/or expanded if required. They established a budget of $2 million for a temporary water treatment and reuse facility.

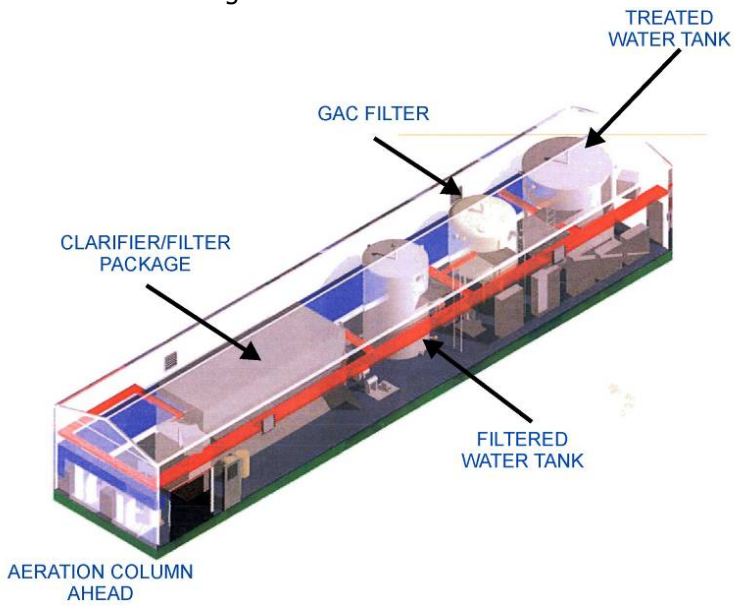
Our team carefully considered the design criteria and the College's immediate needs, and modified the design criteria and water treatment plant design to meet the budget. The modified design criteria included limiting design flow rates to short-term peak demands, operating seasonally, and foregoing sludge treatment. The plant would be built at a reduced capacity of 375 m^3/day (50% of the ultimate capacity) to service the Training Centre's current peak demand. In addition, Associated Engineering recommended design of a skid-mounted treatment unit. When necessary, the water treatment plant could be easily relocated to a new site and/or expanded at its current or future location.

Added Value: The team designed a Water Treatment and Reuse Facility that can be moved and/or expanded when required.

Risk Management: Using design-build delivery approach minimized risk of schedule and budget overruns.

The client's desired timeline and budget constraints required an accelerated implementation process. The team recommended prequalifying contractors, and then working with the contractor in a "design-build" environment, which allowed us to accelerate equipment procurement, and collaborate with the contractor to fast-track design and construction.

The entire facility was built at the contractor's fabrication shop in Edmonton and transported to site for final connections and commissioning.



Water Reuse for Firefighting Training

Lakeland College Emergency Training Centre

Demonstrated Environmental Sustainability

The Water Treatment and Reuse facility allows the Training Centre to minimize and almost eliminate the need to use potable make-up water from the Town of Vermilion. Moreover, the treatment process produces an effluent water quality that meets Alberta Environment's stringent discharge criteria, enabling the client to discharge effluent to a water body, if required.

Environmental Value: The new water treatment plant maximizes water reuse, and minimizes need to discharge to the environment and use of the Town of Vermilion's drinking water.

Benefits an d Achievements

Associated Engineering met the challenge of designing a cost-efficient water treatment facility to treat a difficult waste stream from the Lakeland College Emergency Training Centre. A testament to the success of the project, Mr. Kirk McInroy, technical service manager at the Emergency Training Centre says, "We're very happy with the facility they designed and constructed for us. It's improved the quality of the water we reuse which ultimately reduces the wear and tear on our props and equipment. They did a great job." Appendix C and D contain excerpts of Lakeland College Emergency Training Centre website and the reference website for an interview that Mr. McInroy conducted with local media.

The new water treatment facility allows the Lakeland College Emergency Training Centre to maximize water reuse, minimize reliance on make-up water from the Town of Vermilion, reduce operating costs related to hauling water offsite, minimize waste sent to the municipal sanitary sewer, and improve the quality of water discharged to the environment. Improving the water quality also reduces wear and tear on the fire training pumping equipment and mitigates odour arising from the fire training runoff water holding ponds.

Benefit to Society: The Water Treatment and Reuse Facility allows the Lakeland College Emergency Fire Training Centre to continue to provide emergency training in Alberta.

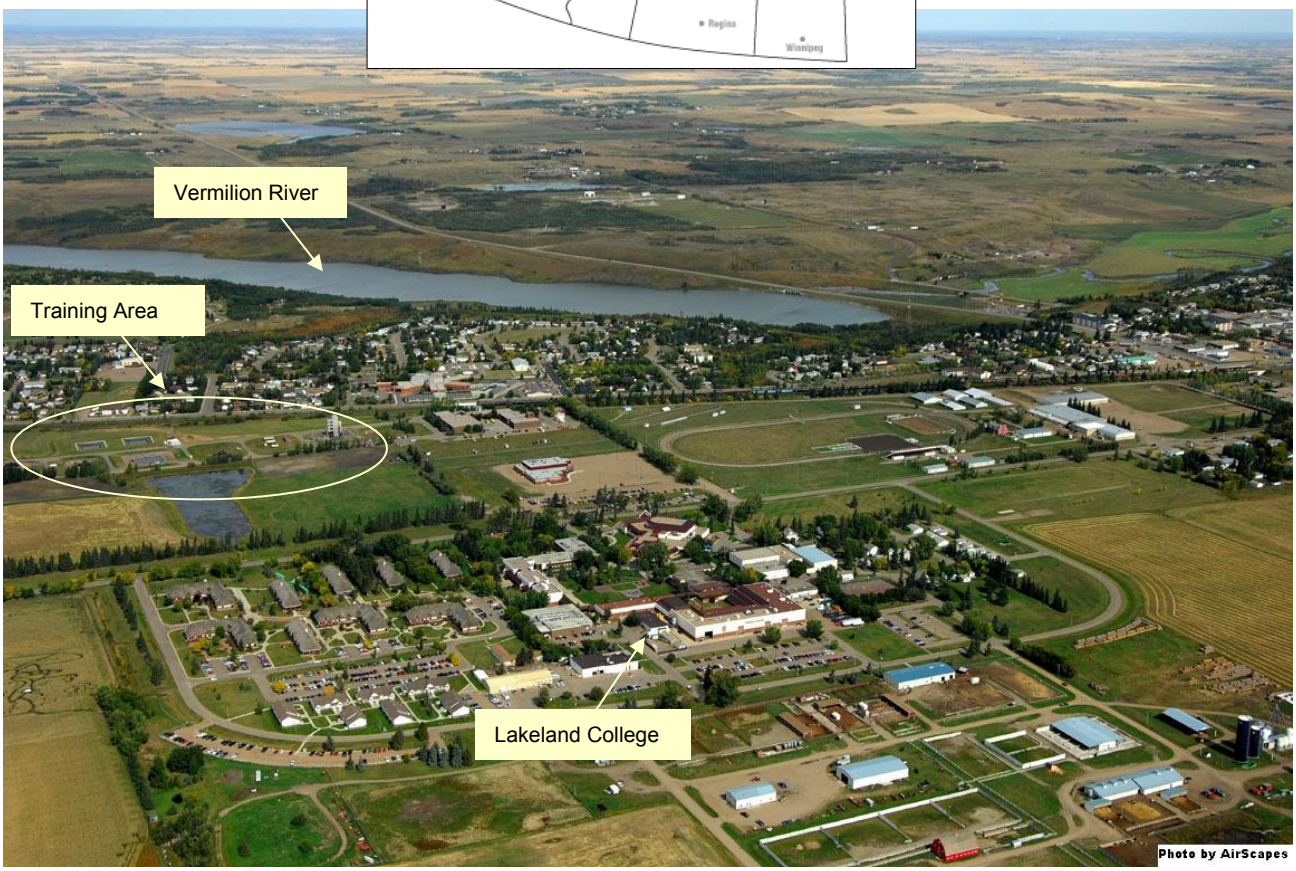
The new Water Treatment and Reuse Facility safeguards our valuable water supply, the environment, and an educational facility that is an important part of the community and the province of Alberta.

Contaminated Water Pond

Treatment Plant Interior

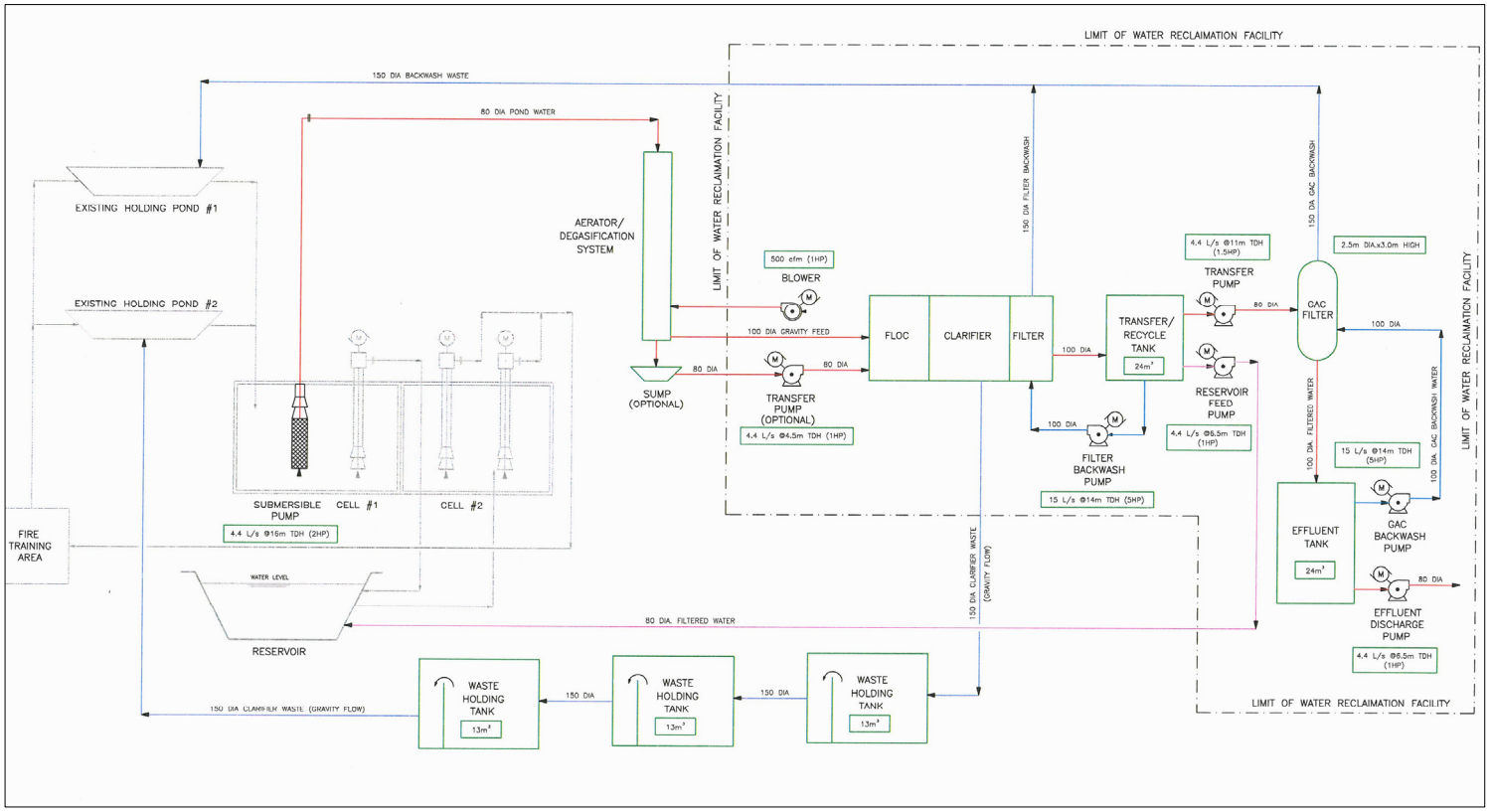
APPENDIX A

Lakeland College Fire Training Facility Location



APPENDIX B

Process Flow Schematic



APPENDIX C

Page from the College's Website on the Facility

http://www.lakelandcollege.ca/news/news02141102.aspx

Emergency Training Centre's water treatment and reuse facility earns award of excellence in environmental category

(Feburary 14, 2011--Vermilion, AB) The company that designed and constructed Lakeland College Emergency Training Centre's new water treatment and reuse facility received a major award last week.

Associated Engineering Alberta Ltd. received the Award of Excellence – Environmental during the Consulting Engineers of Alberta annual Showcase Awards last Friday at the Shaw Conference Centre in Edmonton.

Kirk McInroy, technical service manager at the Emergency Training Centre, attended the award ceremony and was pleased to see Associated Engineering Alberta win the award. 'We're very happy with the facility they designed and constructed for us. It's improved the quality of the water we reuse which ultimately reduces the wear and tear on our props and equipment. They did a great job," says McInroy.

The project began in 2005. Associated Engineering first analyzed the quality of the runoff water and then determined a treatment process for the water. The recommended treatment combined proven processes including air stripping, clarification, filtration and granular activated carbon adsorption. Once the process for treatment was finalized, the Associated Engineering team worked with contractors Eco-Technica and Oncore Services to build a portable water treatment and reuse facility.

The 30 x 6.6 metre facility was built in Edmonton and transported last July to the college's training field in Vermilion. The facility is able to clean up to 350,000 litres of water a day.

The judges had many positive comments about the project. "The team displayed outstanding technical and managerial excellence in creating an innovative, efficient, cost-effective, transportable and expandable solution. This project demonstrated a high degree of dedication to meeting the client's shifting needs."

Lakeland College received a $2.5 million grant from the Government of Alberta to purchase the system.

For more information, media may contact: Kirk McInroy, 780-581-2019.

APPENDIX D

Kirk McInroy's interview to the Local Media

http://www.youtube.com/watch?v=A-7hEFm1xSo