



## **USE4WRM: Recruitment and Retention for Environmental Engineering and Water Resources Management Programs**

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# **USE4WRM: Recruitment and Retention for Environmental Engineering and Water Resources Management Programs**

## **Abstract**

Low-income and underrepresented communities comprise an insignificant fraction (less than 0.5%) in the environmental workforce, particularly in engineering and management positions. The authors' institution is the only Historically Black College and University (HBCU) that offers undergraduate degrees in Water Resources Management (WRM) and Environmental Engineering (ENE). The goal of the NSF sponsored Undergraduate Scholarships for Advancing Education Excellence in Environmental Engineering and Water Resources Management (USE4WRM), an S-STEM grant is to increase the recruitment and retention of the academically talented students majoring in ENE and WRM programs, but also those who are in need of financial assistance through scholarships and other required academic support. USE4WRM aims to ensure the contribution of the workforce from the disadvantaged communities to these specialized fields. It is designed to support the qualified students in academic performance, persistence, graduation, job placement, and entry into graduate schools.

The USE4WRM program will recruit student cohorts of 14 high school students ( 7 males and 7 females), broken into the ENE (8 students) and WRM (6 Students) programs in its five year grant period. They will receive scholarships, mentoring, tutoring and personal development for four years. The program was started in Fall 2016 with four freshmen and for the 2017-2018 period it has selected or identified three more freshmen. Under the guidance of the ENE and WRM faculty, the students form a learning community combining the curriculum with experiential learning through undergraduate research and internships. Academic performance indicators of the cohorts and responses from the scholar surveys are used in program assessment. An external evaluation team evaluates the success of the USE4WRM program.

In the first year, two male and two female applicants were recruited through the application process and supported with \$7500 per academic year scholarship. In Spring 2017, three of them were in ENE program and one was in the WRM program. They enrolled in the First-Year Seminar course specifically designed for STEM students to guide them through the academic and social life in the institution. Two scholars were involved in summer research and mentoring opportunities. In Fall 2018, three scholars had the opportunity to do the paid undergraduate research. Although one student from the first cohort lost the USE4WRM scholarship due to unsatisfactory academic performance, he continues to be an ENE major.

The program spent Fall semester of 2016 and Spring semester of 2017 on engineering accreditation efforts. The ABET reviewers had recognized USE4WRM grant as a major strength of the program in improving the preparation of incoming freshman and their ability to maintain a steady stream of cohorts. The program will use its ABET accreditation status from May 2017 to recruit qualified students into ENE and WRM programs. The knowledge gained within ENE and WRM programs can be extended to other STEM fields. This program will also reduce the underrepresentation in the growing water and environmental professions to address imminent needs.

## **Introduction**

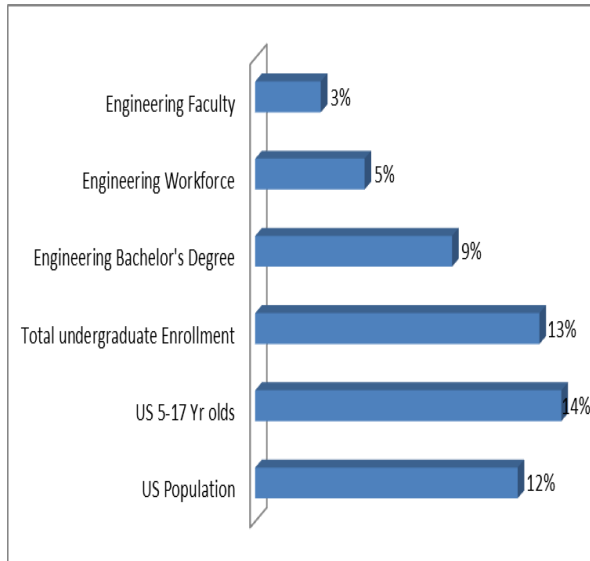
The authors' institution, a land-grant institution, is one of 102 Historically Black Colleges and Universities (HBCUs) in the U.S. It is composed of 95% African-American student population and 59% of pupils from families with incomes below the poverty level as defined by the U.S. Census Bureau. This institution accommodated 8.5% of all undergraduate African Americans at 4-year public universities in its state [1]. In addition to serving the minority students from its own state, in the capacity of an HBCU, it also significantly contributes to the education of African American students in the other parts of U.S., especially for the students from neighboring states.

The Department of Water Resources Management (DoWRM) in the College of Science and Engineering (CSE) houses the undergraduate academic programs, Environmental Engineering (ENE) and Water Resource Management (WRM). The WRM program, one of the first of its kind in the U.S., had 15 undergraduate students in Fall 2015 (at the time of applying for the S-STEM grant from National Science Foundation). The ENE program is the only environmental engineering program among all HBCUs that offers a bachelors degree in Environmental Engineering. In Fall 2017, it is also one of the 47 ABET accredited undergraduate Environmental Engineering programs in the U.S. The enrollment has been steadily improving in the program since it was established in 2008 with the NSF grant, QUEST. Its enrollment was 25 students in Fall 2015.

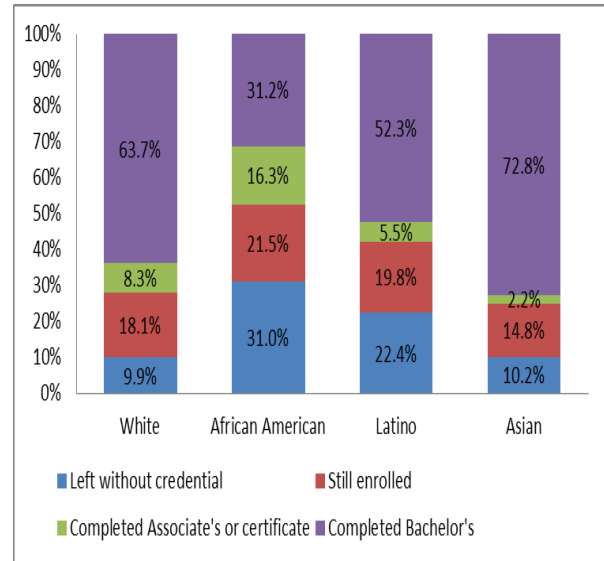
## **Need for the Grant and Rationale**

National Action Council for Minorities in Engineering reported that African Americans are underrepresented in communities of engineering educators and industry engineers for the period of 2008-2010 (Figure 1). Figure 2 shows that African American retention rates are comparatively lower than any other ethnic group in the U.S. [2]. NACME also found the mean ACT scores for mathematics and science were the lowest scores (17.3 and 17.2 respectively) for the African American students for any group, and also displayed the least college readiness with 12% and 5% with respect to mathematics and science [3]. However, it was also reported by the NACME in 2012 was that in the undergraduate level of engineering, women were 8% and men were 5% in 2008-2010 period.

African Americans are underrepresented in Environmental Engineering, given that they comprise only 2.9% of Environmental Engineering while comprising 13.2% of the U.S. population. It is also found that the retention rate of African American students in Engineering programs is low [4]. Civil and Environmental Engineering programs supply engineering workforce for the municipalities, particularly in areas of drinking water supply, wastewater treatment, and solid waste management. The municipalities located in most urban centers across the nation are comprised predominantly of African American or Hispanic populations, and yet African American representation in engineering professions in these municipalities is still very low.



**Figure 1: African American Representation in Selected Groups 2008-2010**



**Figure 2. Retention to Graduation, Computer Science, Engineering, and Engineering Technology, 2003-04 First-Year Students as of 2009**

The reasons for the low retention in the minority undergraduate students were identified in the literature as lack of academic preparedness, campus climate, lack of commitment to educational goals and the institution, problems in social and academic integration and the lack of financial support [5]. The authors' institution, the only HBCU with the Water Resources Management and Environmental Engineering majors, has a professional and ethical obligation to change this situation by providing financial support and academic guidance through the faculty and peer mentorship to the African American students, especially the female students from the low-income families.

In addition, the department also wants to increase the diversity of the program with respect to gender and race. These were the rationales behind the CSU's S-STEM - Strand 1: STEM Institutional Capacity Building grant application with the proposal, *Undergraduate Scholarships for Excellent Education in Environmental Engineering and Water Resources Management (USE4WRM)*.

## USE4WRM Objectives and Plans

### *USE4WRM Objectives*

USE4WRM proposed the following three objectives to enhance the educational opportunities in WRM and ENE for potential students from low-income communities.

- 1. Increase the enrollment numbers and the academic preparedness of the ENE-WRM majors selected from the low-income communities**

In Fall 2015, there were 15 Water Resources Management and 25 Environmental Engineering Majors in DoWRM. USE4WRM plans to recruit students through scholarships and increase enrollment by 32% in ENE and 40% in WRM during the grant period. This will directly increase the enrollments in ENE and WRM to 33 and 21 at the end of the project period. USE4WRM will also attempt to maintain an even distribution of 7 male and 7 female students through the grant. This will increase the number of female students to 20 and that of male students to 34, and raise the male to female student ratio from 1:2 to 1:1.7. We will also raise minimum qualifications for a USE4WRM scholar. The minimum GPA requirement will be 3.0 and/or the minimum ACT requirement for the freshmen of 22. Table 1 provides a summary of the proposed cohort scholarship distribution. An in-state full-time student will get maximum \$7,500 per year and an out-of-state full-time student will get maximum \$10,000 per year.

**Table 1: Proposed cohort scholarship distribution under USE4WRM**

Cohorts	Majors (Category)							Support				
	ENE	WRE	Instate	out of state	male	female	Total	Years	Start	Finish	Support Level%	Start Level
First	4	3	4	3	4	3	7	4	2016 Fall	2020 Spring	100	Freshmen
Second	4	3	4	3	3	4	7	4	2017 Fall	2021 Spring	100	Freshmen
<i>Total</i>	8	6	8	6	7	7	14					

**2. Increase the retention of the ENE-WRM majors in the low-income community at CSU**

USE4WRM targets an increase in retention of the incoming freshman and sophomore USE4WRM Scholars to 80%, junior level scholars to 90% and senior level scholars to 100% while expecting the scholars to maintain a cumulative GPA of 3.0 or better.

**3. Increase the career and graduate school opportunities to the ENE-WRM graduates**

We target ten internship placements or undergraduate research opportunities for the USE4WRM scholars in the proposed five year period. 80% of the USE4WRM scholars are expected either to enter the workforce or pursue graduate studies.

***Project Plans***

**1. Provide scholarship for undergraduate students in Environmental Engineering and Water Resources Management to enroll**

Low-income in-state students pursuing WRM/ENE majors will receive \$7,500 per year as three cohorts, and the out-of-state WRM/ENE majors will receive \$10,000 per year as two cohorts (Table 1). This will reduce the financial burden of the students which was identified as one of the major reasons for high dropout rates among African American students [5].

**2. Improve the student support system to enhance the retention rates**

Higher student retentions are expected by offering to tutor in gateway STEM courses for WRM/ENE majors and English. Environmental Professional Seminar course will be

introduced at the sophomore level. A section of current First Year Seminar (FYS) course will be offered exclusively for ENE/WRM majors.

### **3. Enhance the internship opportunities and streamline the mentorships**

Students will be provided industrial experiences. Professional networking opportunities will be created as they graduate. They will be assisted in securing field internships. WRM/ENE faculty will assist USE4WRM scholars in their academic goals. Faculty members are expected to provide advising to sustain high academic performance and mentoring to prepare them for professional careers.

### **4. Enhance the career development guidance and improve the graduate school preparation process**

Academic mentors and industry mentors will guide and help students in career development. CSO and the USE4WRM management team will help with Graduate Record Examination (GRE) preparation processes and will provide graduate school visits. Academic mentors will also help the students in their graduate studies with their networks, guidance, and recommendations.

## **USE4WRM Status: September 2016- January 2018**

Since the initiation of the activities related to the grant in September 2016, the following activities were carried out with respect to the grant objectives:

### **1. Increase the enrollment numbers and the academic preparedness of the ENE-WRM majors selected from the low-income community at Central State University (CSU)**

USE4WRM scholarship information was included in the departmental brochure for Environmental engineering and few university brochures. A one-page informational flyer and a two-page application form for the intended students were developed for the recruitment purposes. The scholarship information was provided to Campus Admissions Office and to the University Public relations for dissemination to feeder schools. Since the award was confirmed only in the early June of 2016 which is well after the college application period, the first batch of USE4WRM scholars was recruited from the already applied ENE and WRM majors and the pool of university students who were undecided about specific majors but showed interest in STEM majors. Four students -two females and two males- met the qualifications from nine applicants. While PI/Co-PIs assessed their academic credentials by reviewing their high school transcripts, resumes, recommendation letters and personal essays, the financial aid office assessed and established the financial need of the students. Although at the beginning of Fall 2016 there were two WRM majors and two ENE majors, at the end of Fall 2016, there were three ENE majors and one WRM major since one of the students changed her major to ENE. In the 2017-2018 period, though, there were three students identified for the scholarship, only two are confirmed with their performances in Fall 2017 semester.

The recruitment activities were carried out by the PI/co-PI through school visits, school and professional conference career fairs, high school student job shadowing, and e-mail communications with the school counselors in the region. The number of school visits and interactions with school counselors increased from Fall 2017 when the campus USDA liaison officer joined the recruitment team. One of her main duties is to increase recruitment of STEM majors and expand efforts to increase minority representation in USDA workforce in Natural Resources, Agriculture, Food, Engineering, and Technology. She has been assisting PI/Co-PIs in recruitment, distribution of the USE4WRM informational materials, and dissemination of scholarship information to high school students during her school visits. For the academic year of 2017-18, 34 students applied as freshmen. 55% were from out-of-state, 28 were for the ENE program, and six were for WRM. Only nine accepted and attended CSU's DoWRM; seven joined the ENE program and two joined for WRM, which was not a significant difference from the previous year.

In Spring 2018, the frequency of the school visits has increased with the support of the PI/CoPIs' efforts, USDA liaison officer's and the current students' participation in the school visits. It has helped so far to confirm for incoming freshmen who are eligible and showed interest in the scholarship.

## **2. Increase the retention of the ENE-WRM majors from the low-income students at CSU**

Scholarships provided relief to students by lowering their student-loans significantly and allowing them to focus on academics. A freshman seminar course was enhanced with the academic preparedness components specifically for the STEM majors. It helped them to smoothly adjust to university life from high school life. Students also had access to the academic advisors and the faculty advisors to discuss the issues that could impact their academic performance. Students were informed about the opportunities for the other scholarships and internships. Since Fall 2016, USE4WM scholars were also recipients of other scholarships such as NSF LSAMP, Improving Pathways for STEM Student Retention and Graduation (NSF IPSRG), Diversifying Ohio through STEM (DO-STEM), and Alumni scholarships, and financial support that have helped them to be financially stable and enabled them to be able to focus on the studies. In January 2018 two of the scholars are also eligible for other scholarships from USDA. The students also met the external program evaluators in each semester and the reports from the evaluators were used by the PI and CoPIs to improve USE4WRM.

## **3. Increase the career and graduate school opportunities to the ENE-WRM graduates**

USE4WRM awardees and other ENE and WRM students were frequently provided with the information on summer internships and scholarships offered at other academic institutions, such as NSF REUs. They also were provided with the opportunities to attend career fairs and to go for field visits. In addition, they have gotten involved with professional activities through the professional societies such as YWEI (Young Woman's Empowerment Institute), NSBE (National Society of Black Engineers), and MANRRS (Minorities in Agriculture Natural Resources and Related Sciences). At the beginning of Spring 2018, four USE4WRM recipients

are mentored by three WRM|ENE faculty members in paid undergraduate research from other research and educational grants.

## **Significant Results**

Since its establishment in Fall 2017, USE4WRM supported five scholars. However, the recruitment for the programs in this period fell short of the USE4WRM target. It could have been due to the availability of a short interval between the S-STEM award announcement and the school application deadlines for recruitment in the first year. While the applicants for 2017-2018 had improved the number of applicants for both programs, the actual enrollment did not live up to the expectation. This could have been due to the yet-to-be-accredited status of the ENE program. In 2017, ABET reviewers for the ENE program cited the USE4WRM scholarship program as a major strength of the program in building a stronger cohort of students in future with better academic preparation. These students will be able to improve student outcomes for the program and increase graduation rates. The program was accredited in 2017 Fall.

The Fall 2016 and Fall 2017 assessments by the USE4WRM scholars shows high student satisfaction with the programs and the scholarship award. In Fall 2017, all the USE4WRM scholars held the GPA above 3.00 so that they could continue as the scholars for Spring 2018. First Year Seminar course for the STEM freshmen helped the majors to adjust and assimilate smoothly into the STEM academic environment.

## **USE4WRM: From February 2018 to Future**

USE4WRM played a role in securing ABET accreditation for the Environmental Engineering program. The PI and CoPIs expect the ABET accreditation and the recent surge in society's interest in environmental issues can improve the recruitment in Environmental Engineering program. There has been a reawakening for the nation to addressing the nation's deteriorating water and environmental infrastructure AS catastrophic events such as Flint's drinking water contamination, Lake Erie's harmful algal blooms, and the BP oil spill in the gulf occur, all of which disproportionately impact minority communities. Both climate change effects and environmental concerns demand an increase in the share of renewable sources of energy. Both natural resources and environmental fields will be sought upon by the society to solve these rather urgent problems. We anticipate this will enhance the interest of students in our ENE and WRM programs. Support from USE4WRM scholarships will increase their opportunity to enroll in these majors and focus on academic performance and career preparation rather than worry about their financial burdens. The PI and Co-PIs are planning to improve the visibility of the programs and the awareness of the fields among the underrepresented as well as low-income communities through school visits, community programs and summer programs with USE4WRM and other means. They also intend to involve the current USE4WRM scholars in the recruitment process.

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