NORTHERN ARIZONA UNIVERSITY

MEMORANDUM

To: Pacific Southwest Conference Grading Committee
From: Northern Arizona University Environmental Design Team
Date: March 15, 2018
Subject: Environmental Design Report

Attached is Northern Arizona University's design report submission for the Environmental Design Competition in regards to the 2018 Pacific Southwest Conference hosted by the American Society of Civil Engineers chapters of Arizona State University and Northern Arizona University. If you have any questions, please do not hesitate to contact us.

Thank you,

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Northern Arizona University
Environmental Design Competition

Environmental Engineering Seniors:

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March 15, 2018

Executive Summary

The Northern Arizona University (NAU) Pacific Southwest Conference (PSWC) Environmental Design team is composed of four members: Alex Anzar, Shelby Carawan, Paige Reilly, and Cameron Rhodes. All members are senior environmental engineering students attending Northern Arizona University located in Flagstaff, Arizona.

The wastewater treatment final design is gravity fed and composed of a series of filtration levels. First, the water will be allotted eight minutes to settle in a large bin. The water will then be transferred to the top tier of the design consisting of a five gallon bucket filled with sand that is used to treat for turbidity. The wastewater then enters the second tier, a five gallon bucket filled with ion-exchange resin, to decrease the phosphorus and nitrogen levels within the water. To ensure all contaminants are treated for, the remaining water will pass through the third tier which is composed of a five gallon bucket filled with granular activated carbon. Each bucket opening will be wrapped with 100% cotton cloth and fastened to the bucket with a rubber band. Once the treated water has passed through the system, it will be collected in a final five gallon bucket containing a specified amount of bleach [A-1].

Upon collecting the treated water, the water quality results may be obtained for each of the specified parameters: Total P-PO_4^{3-}, Total N-NO_3^-, turbidity, chlorine, total coliforms, and odor.

The total cost of the system is $436.81 [A-2].

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ASCE	American Society of Civil Engineers
ASU	Arizona State University
Cl^-	Chlorine ion
CTU	Colony-Forming Unit
g	Gram
GAC	Granular Activated Carbon
In.	Inches
L	Liter
mg/L	Milligrams per Liter
mL	Milliliter
$N\text{-}NO_3^-$	Total Nitrogen as Nitrate
NAU	Northern Arizona University
NTU	Nephelometric Units
$P\text{-}PO_4^{3-}$	Total Phosphorus as Phosphate
ppm	Parts per Million
PSWC	Pacific Southwest Conference
PVC	Polyvinyl Chloride
WHO	World Health Organization

1.0 Introduction

844 million people currently do not have access to safe water [1]. Of these individuals, 842,000 die each year from diarrheal diseases related to contaminated drinking water [1]. The United Nations have set sustainable development goals; one of which is to achieve universal and equitable access to safe and affordable drinking water for all by 2030 [2]. Household water treatment technologies are being considered to help reach this goal. However, the cost of these devices are not feasible for production in developing areas, such as Ethiopia and Bangladesh. Low-cost, low-technology treatment systems are needed in order to quickly improve the health and well-being of populations within developing countries.

1.1 Project Description

The purpose of the ASCE Environmental Design Competition is to design and construct a low technology, low cost water treatment device that may be utilized within the households of developing nations. The 2018 Pacific Southwest Conference will be hosted by ASU and NAU and held at ASU's campus located in Tempe, Arizona on April 12, 2018 [3].

The PSWC Environmental Design rules have outlined simulated wastewater with the following contaminants [3]:

- 1000 g Miracle Gro All Purpose Plant Food
- 1000 g Bulk Apothecary Kaolin Clay
- 30 mL Star Kay White Pure Lavender Extract
- 20 mL Wastewater Treatment Plant effluent

The simulated wastewater must be treated to the following the standards [3]:

- 1 mg/L Total P-PO_4^{-3}
- 10 mg/L Total N-NO_3^-
- 1 NTU
- 4 ppm residual chlorine
- No presence of coliforms
- No presence of odor

The competition requires teams to construct their wastewater treatment device within a 3.05m x 3.05m area. Thirty minutes are allotted for the construction of the device. After construction, teams will be allowed ten minutes to pour the 34L sample into the treatment system. Another twenty minutes is then permitted for the system to treat the contaminated water. A treated water sample will be collected and a series of tests will be conducted to measure the contaminants within the treated water. Budgets must not exceed $500. This includes all materials and equipment found inside the 3.05 m x 3.05 m space during the construction portion of the competition [3].

1.2 Project Scope

In order to design a wastewater treatment device that successfully provides potable water in accordance with World Health Organization (WHO) standards [1], a thorough literature review was conducted regarding water treatment methods and developing country resources. Then, treatment components were prototyped for the individual testing parameters. These components were combined into the final design and tested for effectiveness. Finally, the water treatment design was presented at the PSWC and ranked against 18 other universities on its proficiency.

2.0 Methodology

The following information identifies the methods utilized throughout the environmental engineering design process to conduct water quality analysis specific to the PSWC Environmental Design competition.

2.1 Equipment and Materials

The equipment utilized throughout the water quality testing are listed within the methods identified in Table 1.

2.2 Equations

The equations used all pertain to the quantity of Clorox Bleach needed for the determined level of residual chlorine.

Equation 1: Volume of Clorox needed

$$Clorox\ (L) = 0.01\ L\ Cl^{-} \times \frac{100L\ Clorox}{\%\ Available\ Cl^{-}} \times \frac{Dose}{10\ L\ Water} \times \frac{L\ Water}{1{,}000}$$

Where Cl^- is chlorine, Dose is the volume (mL) of 1% stock solution needed to raise 10 L of treated water the desired residual chlorine level, and the volume of water is divided by 1,000 to convert Dose into liters. Dose is determined by a series of tests using 10 L samples.

2.3 Procedure

The testing methods outlined in Table 1 were used for initial and final design testing.

Table 1: Water Quality Parameter Testing Methods

Parameters	*Methods*
$P\text{-}PO_4^{3-}$	HACH Method 8048: Phosphorus, Reactive (Orthophosphate) [4]
$N\text{-}NO_3^{-}$	HACH Method 8039: Nitrate [5]
Turbidity	HACH Method 8237: Turbidity [6]
Total Coliforms	HACH Method 8074: Coliforms, Total, Fecal and E. Coli [7]
Odor	Blind Odor Test [8]
Chlorine	HACH Method 8021: Chlorine, Free [9]

2.3.1 Research and Initial Testing

In order to meet the objectives of this project, first an extensive literature review was conducted. The contaminants of the simulated wastewater and the respective treatment methods to eliminate these contaminants were researched. Then the wastewater sample was reproduced with the contaminants specified in the 2018 PSWC Environmental Competition Rules. The sample was tested for the following parameters outlined in Table 1: phosphorous as orthophosphate, nitrogen as nitrate, turbidity, total coliforms, and odor.

2.3.2 Component Design and Testing

The parameters tested for in the competition correspond directly with the WHO standards. The alternatives considered are the specific units for each of the water quality parameters: turbidity, $P\text{-}PO_4^{3-}$, NO_3^{-}, odor, coliforms, and chlorine. After testing each unit prototype, the most effective treatment units are to be integrated within the final design. As a result, this will produce a well scored and high functioning system which may be used for real life application.

2.3.2.1 Turbidity

Based on the literature review, the alternative unit designs for turbidity primarily consist of filtration and sedimentation [10]. The filter prototypes that have been tested for performance, vary in regard to filter media. Those media include gravel, sand, zeolite, cotton, silk, and polyester fabrics. No pressurized systems are being considered due to the additional technology that it would require. The other method for turbidity removal is sedimentation. Because clay is the primary contributor to the turbidity, a sedimentation system has been prototyped for initial removal of clay.

2.3.2.2 Nitrate and Phosphate

Nitrate and phosphate are parameters which require chemical or biological systems for effective removal [11, 12]. Nitrogen is removed from water through the processes of nitrification and denitrification [12]. Both of these biological methods are carried out by microorganisms. Ion exchange can also be used to exchange undesired nitrate ions for other ions of a similar charge by passing the water over ion-exchange resin beads. This exchange can be done with the chemicals described for phosphorus, but research suggests that the Moringa seed may act as a substitute where resources are limited [12].

Phosphorus is mainly treated through chemical or biological methods. Flocculants, such as aluminum or iron cations, are added to a water sample in order to react with phosphorus; this causes phosphorus to precipitate and allows the precipitate to be removed through physical processes. Microorganisms that store phosphorous can also be used within the waste activated sludge process. Waste activated sludge can then be removed by other physical processes [11].

Because of the 30 minute treatment time constraint associated with the competition, biological methods are not realistic for this project. Chemical removal of the nutrients was the main alternative being explored. Flocculants, cation resins, and nitrate reduction using inorganic materials were all researched. Resin was decidedly the best alternative for nutrient removal.

2.3.2.3 Odor

Odor can be treated by using granular activated carbon (GAC). The large surface area provided by the material removes the source of odors. GAC has proven to be effective for sulfur-based odors [13]; however, the source of odor in the simulated sample is lavender extract oil. Other methods, such as biological membranes, are not being considered due to the time constraint.

2.3.2.4 Disinfection

Total coliforms are treated through the use of disinfection which may include UV disinfection, distillation, or chlorine addition. As stated previously, filtration can remove some of the bacteria, however additional treatment is necessary [14].

Chlorine will be used as a disinfectant and will require a residual level of 4 ppm. This unit will take place towards the end of the treatment system to ensure bacteria and pathogens are properly inactivated, and residual levels are maintained. In order to avoid the formation of trihalomethanes, granular activated carbon will succeed the chlorine disinfection process [1, 14].

2.3.3 Final Design and Testing

Different support structures were considered including a 2 in. x 4 in. wooden apparatus, plywood shelves, and stacked buckets. PVC pipe was also examined as a method to transport water from one unit to the next. Manual pouring, a perforated pipe, and a ball valve were considered for draining of clear water after the sedimentation step. Design alternatives yielding the most effective results for each component were compiled into the final design.

2.4 Software

Autodesk AutoCAD 2018 was the only software used in the design process. The program was able to accurately provide a scaled model of the design. Numerous layers were utilized to properly identify the various design components and materials. Throughout the construction and water quality testing processes, the design was able to be modified and adjusted accordingly. This design can be viewed in A-1.

2.5 References

Three main sources of direction for this project include NAU professors Alarick Reiboldt and Dr. Terry Baxter as well as the NAU Laboratory Manager, Adam Bringhurst. Scholarly journals were referenced for research purposes and can be viewed in Section 6.0 References.

2.6 Field Work

To gain adequate results the team assembled a prototype of the final treatment unit. The team pre-drilled the 2 in. by 4 in. wooden studs, pre-cut the plywood, and pre-cut the five gallon buckets. The team also simulated final design construction in a thirty minute time frame by tightening the screws and fabricating the entire system. The buckets were filled with their respective filter media and the simulated wastewater was ran through the treatment device. This treated water was then tested for the specified parameters.

3.0 Results of Analysis

The results of this project are distinguished by three sections including testing results, final design, and cost analysis. Please refer to the following subsections for further detail.

3.1 Testing Results

The following table gives the testing results of the initial raw water sample.

Table 2: Initial Raw Sample Results

Parameter	*Value*	*Units*
P-PO_4^{3-}	3,990	mg/L
N-NO_3^-	50	mg/L
Turbidity	> 1,000	NTU
Total Coliforms	Present	CFU
Odor	Present	Unitless

As demonstrated in Table 2, all five parameters for the raw water sample are not in compliance with the desired WHO standards. The P-PO_4^{3-}, N-NO_3^-, and turbidity readings were too high in value to be read by the meters.

Table 3 below outlines the results from the component testing.

Table 3: Unit Prototyping Results

Parameter	*Unit*	*Trial 1*	*Trial 2*
$P\text{-}PO_4^{3-}$	mg/L	210	180
$N\text{-}NO_3^{-}$	mg/L	5	49.1
Turbidity	NTU	> 1000	192
Total Coliforms	CFU	Present	Not Present
Odor	Unitless	Present	Reduced

Unit prototype testing was conducted in relation to each water quality parameter. Table 3 highlights the various data obtained from each water quality parameter test. A total of two trials were conducted for each parameter.

In order to successfully reduce the phosphorus and nitrogen content within the sample, the water was percolated through a series of filtration pads. Within the first trial, the water was treated using three different media filtration pads: Acurel LLC Phosphate Reducing Media Pad, Acurel LLC Nitrate Reducing Media Pad, and an Acurel LLC Ammonia Reducing Media Pad. This filtration method had no impact on the initial water sample quality. As a result, an ion-exchange resin was utilized throughout the second trial. The amount of nitrogen and phosphorus within the water significantly decreased, thus proving the ion-exchange resin to be an effective method.

For the first turbidity trial, the raw water sample was filtered through various forms of cloth. The turbidity reading remained too high to be read by the turbidimeter. The second trial incorporated a sedimentation period to allow the clay to settle at the bottom of the container. The clearer water was then slowly transferred to a sand filtration container. This trial resulted in a turbidity reading of 193 NTU and was adopted into the final design.

The first trial to reduce total coliforms utilized liquid chlorine. It eliminated the coliforms present. Bleach was used in the second trial due to its cost effectiveness. It again removed the coliforms and was therefore integrated into the final design.

In order to remove odor from the system, it was first assumed that the simulated water would contain no odor if the other parameters were treated for effectively. This was proven as false when odor resulted in trial 1. The simulated wastewater was filtered through granular activated carbon, and although still present, the odor is reduced.

3.2 Final Design

Table 4 below gives the final design treatment results integrating the components described in the above subsection.

Table 4: Final Design Treatment Results

Parameter	*Value*	*Units*
$P\text{-}PO_4^{3-}$	200	mg/L
$N\text{-}NO_3^{-}$	2.1	mg/L
Turbidity	190	NTU
Total Coliforms	Not Present	CFU
Odor	Present	Unitless
Chlorine	4	ppm

In order to effectively design and construct the water treatment device, a series of filtration processes are needed to improve the water quality of the sample. The final design is a gravity fed system and contains a series of five filtration steps. Table 5 on the following page describes the various steps throughout the filtration process:

Table 5: Final Design Filtration Steps

Step	*Process*	*Description*
1	Sedimentation	For a duration of eight minutes, the clay particles will undergo the process of sedimentation within a large storage bin. After the clay settles, the clearer water on top will be poured into a five-gallon bucket for easy transfer to the next step.
2	Sand filter	The water will percolate through the sand filter in order to decrease turbidity.
3	Ion-exchange resin	The phosphorus and nitrogen content within the water will be decreased through the process of ion-exchange. Approximately 4.5 kilograms of resin are utilized in the design.
4	Granular activated carbon	About 4.5 kilograms of granular activated carbon will be in the third bucket of the tiered system. Its purpose is to reduce the odor from the lavender extract contaminant.
5	Collection bucket	Treated water will be collected in this step. Already in the container will be 0.14 mL of bleach. This will disinfect the water of coliforms.

A system diagram of the final design can be viewed in A-1.

3.3 Cost Analysis

Table 5 located in A-3 outlines all the items used within the construction period, as well as their associated costs and quantities. All receipts can be found in A-2.

The total cost for system is $436.81.

4.0 Discussion

4.1 Evaluation of Results

Overall, the nitrate, phosphate, turbidity and total coliforms in the simulated wastewater were significantly reduced. Within the rules of the competition, it is impossible to meet WHO drinking water quality standards; however, the presented water treatment design could be further developed in future projects in order to be effectively used within the households of developing areas.

4.2 Discussion of Legitimacy

Each parameter was tested in accordance with a published standard method. The methods used allow for accuracy and precision when running the various tests. Proper dilution standards were conducted when measuring initial raw water samples to determine an accurate value for phosphate, nitrate, turbidity, and total coliforms.

4.3 Discussion of Challenges

Due to time constraints, biological methods could not be used to treat the wastewater. These methods however would have been the most effective way of removing nutrients from the wastewater. The timing issue and rules of the competition also caused chemical coagulation and flocculation to be unreasonable. These chemical methods would have been more successful at removing the turbidity of the water. Moringa seeds were a cost-effective alternative for treating turbidity, but this natural coagulant requires at least two hours for treatment. It is recommended for future projects that more time be allowed for the treatment process, so that more effective units can be integrated into the design.

5.0 Conclusion

Through the conduction of research, lab testing, and prototype testing, a final water treatment design may be properly constructed and utilized throughout developing countries. Although, due to the unrealistic water quality parameters set forth and the over saturation of contaminants within the water sample, the proposed treatment system design is unable to treat the water in accordance with the WHO standards. As a result, the final design must be modified before implementation and usage.

6.0 References

[1] "Drinking-water," World Health Organization, 2018. [Online]. Available: http://www.who.int/mediacentre/factsheets/fs391/en/. [Accessed: 09- Feb- 2018].

[2] Arizona State University. (n.d.). United Nations Sustainable Development Goals. [online] Available at: https://sustainability.asu.edu/sustainable-development-goals/ [Accessed 23 Feb. 2018].

[3] Pacific Southwest Environmental Design Competition. City of Flagstaff: Northern Arizona University, 2017, pp. 1-9.

[4] Phosphorus, Reactive, HACH Method 8048, Edition 10, 01/01/2017

[5] Nitrate, HACH Method 8039, Edition 9, 01/01/2014

[6] Turbidity, HACH Method 8237, Edition 8, 04/01/2013

[7] Coliforms, Total, Fecal and E. coli, HACH Method 8074, Edition 10, 04/01/2017

[8] Odor, Standard Method 2150, 01/07/1997

[9] Chlorine, Free, Method 8021, Edition 9, 01/01/2014

[10] Turbidity Removal for Small Public Water Systems. (1983). *National Service Center for Environmental Publications (NSCEP)*, [online] pp.1-33. Available at: https://nepis.epa.gov [Accessed 23 Feb. 2018].

[11] "Phosphorus Treatment," Minnesota Pollution Control Agency, [Online]. Available: https://www.pca.state.mn.us/sites/default/files/wq-wwtp9-02.pdf. [Accessed 30 October 2017]

[12] D. Nourmohammadi, et al. "Nitrogen Removal in a Full-Scale Domestic Wastewater Treatment Plant with Activated Sludge and Trickling Filter," *Journal of Environmental and Public Health*, vol. 2013, p. 6, 2013

[13] Drinking water treatment: Activated carbon filtration. (2013). *Neb Guide*. [online] Available at: http://extensionpublications.unl.edu/assets/pdf/g1489.pdf [Accessed 23 Feb. 2018].

[14] Chlorine disinfection. (2018). [eBook] National Small Flows Clearinghouse. Available at: http://www.nesc.wvu.edu/pdf/WW/publications/eti/Chl_Dis_gen.pdf [Accessed 23 Feb. 2018].

7.0 Appendices

A-1: AutoCAD Final Design Rendition

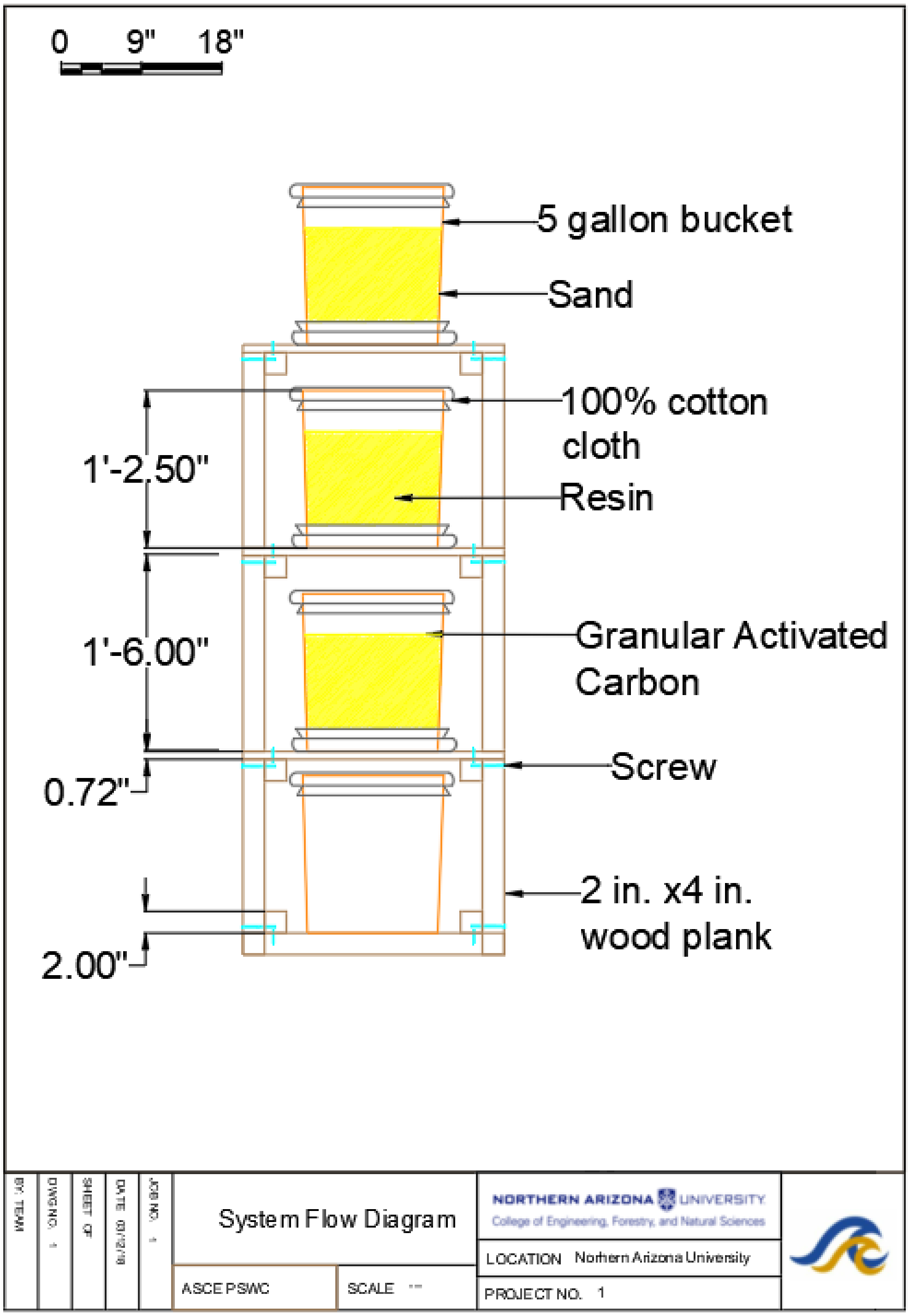

Figure 1: System Diagram

A-2: Cost Breakdown

Table 6: Total Cost of System

Item	*Vendor*	*Unit*	*Cost Per Unit*	*Quantity*	*Total cost*
2 in. by 4 in. Prime Stud	Home Depot	104.625 in. Stud	$3.77	4	$15.08
Plywood	Home Depot	48 in. x 96 in. Sheet	$9.98	1	$9.98
5 Gallon Bucket	Home Depot	1 Bucket	$3.25	5	$16.25
Screws	Home Depot	90 nails	$8.38	1	$8.38
30 Gallon Storage Tote	Home Depot	1 Tote	$9.97	1	$9.97
Screwdriver	Home Depot	1 Screwdriver	$0.87	4	$3.48
Men's Crew T-Shirts	Walmart	10 T-Shirt Pack	$19.93	1	$19.93
Rubber Bands	Walmart	64 Bands	$1.27	1	$1.27
Deionization Resin	Amazon	5 Pounds	$45.00	4	$180.00
Bleach	Amazon	30 Ounces	$8.14	1	$8.14
Activated Carbon	Amazon	39 Ounces	$16.99	8	$135.92
Sand	Amazon	50 Pounds	$28.41	1	$28.41
Total Cost					*$436.81*

A-3: Receipts

More saving.
More doing.

1325 WEST ROUTE 66
FLAGSTAFF, AZ 86001 (928)556-1529

0482 00001 83681 03/11/18 04:22 PM
CASHIER OLIVIA

084305355546 HOMER BUCKET <A> 3.25
5 GAL BUCKET-HOMER LOGO (ORANGE)
712216013087 FASTENERS <A> 8.38
10X3" SPAX MULTIMATERIAL - 1 LB
811187010221 2X4 PH SCREW <A>
#2 X 4 IN PHILLIPS SCRWDRIVER
4@0.87 3.48
857328002007 3/8 PART BD <A> 9.98
0.369IN 3/8 CAT PB 48IN X 96IN

SUBTOTAL 25.09
SALES TAX 2.25
TOTAL $27.34
XXXXXXXXXXXX8312 VISA USD$ 27.34
AUTH CODE 09245B/8014879 TA
Chip Read
AID A0000000031010 Visa Credit
TVR 8080008000
IAD 06010A03608000
TSI 6800
ARC 00

0482 01 83681 03/11/2018 8955

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POLICY ID DAYS POLICY EXPIRES ON
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HTJ 168133 167652

Password:
18161 167651

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Figure 2: Receipt for Bucket, Screws, Screwdrivers, and Plywood

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1325 WEST ROUTE 66
FLAGSTAFF, AZ 86001 (928)556-1529

0482 00058 42869 02/02/18 11:46 AM
SELF CHECK OUT

739236303066 ABS FLANGE <A> 6.53
3"X4" ABS FLANGE HUBXINSIDE FIT
032888076365 PVC BALL VLV <A> 6.92
1-1/4" PVC BALL VALVE SLIP SCH40
073149736666 30GALSTGBX <A> 9.97
30-GALLON STORAGE TOTE
043374046304 WEATHERSTRIP <A> 7.39
MD 2"X100' WS TAPE - CLEAR
078864178500 PTFE TAPE <A> 0.97
1/2"X260" PTFE THRD SEAL TAPE

SUBTOTAL 31.78
SALES TAX 2.84
TOTAL $34.62
XXXXXXXXXXXX8312 VISA
USD$ 34.62
AUTH CODE 00770B/5580247 TA
Chip Read
AID A0000000031010 Visa Credit
TVR 8080008000
IAD 06010A03608000
TSI 6800
ARC 00

0482 58 42869 02/02/2018 8867

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2PX3 86509 86085

Password:
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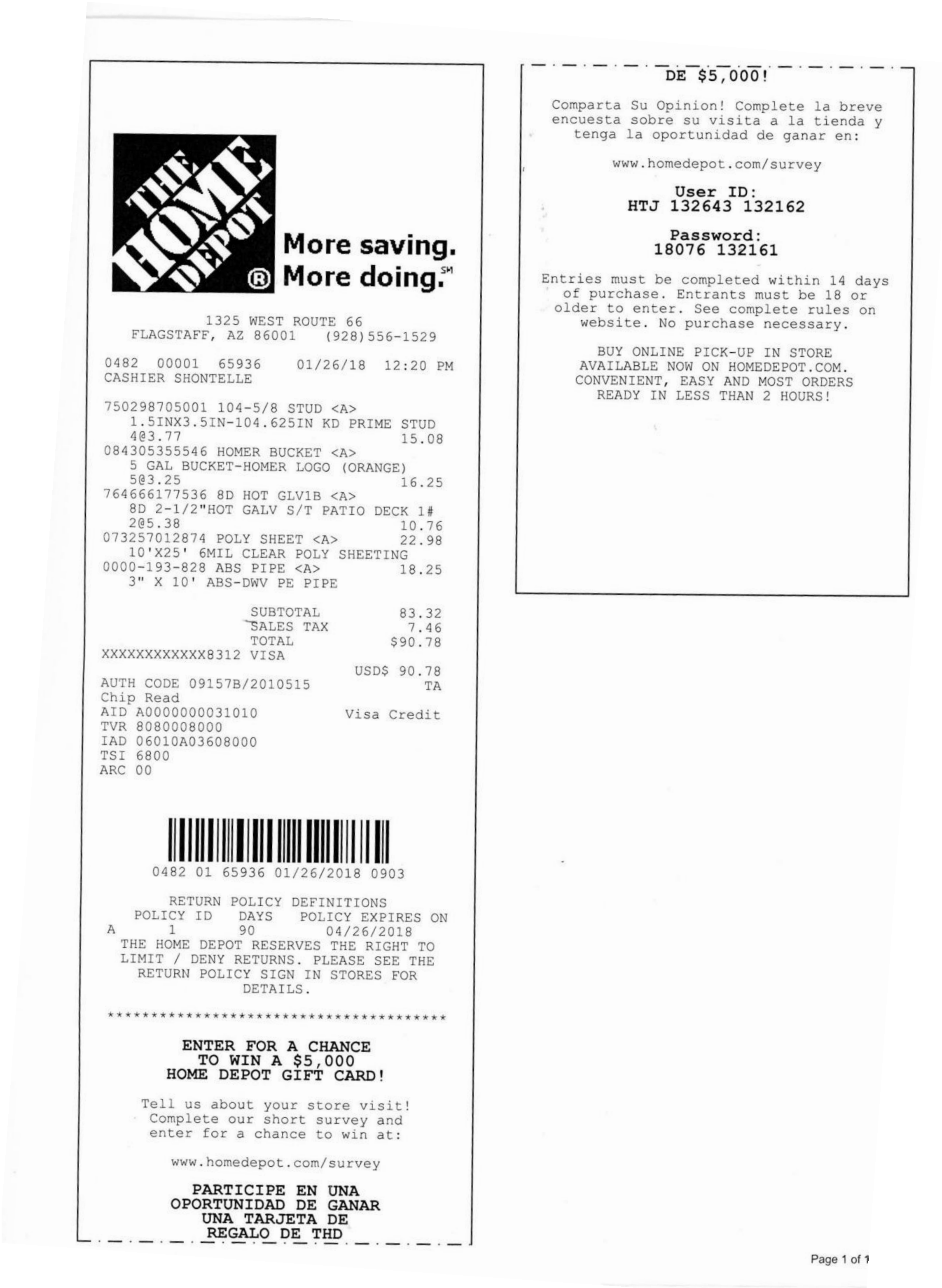
Figure 3: Receipt for Storage Bin



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0482 00001 65936 01/26/18 12:20 PM
CASHIER SHONTELLE

750298705001 104-5/8 STUD <A>
1.5INX3.5IN-104.625IN KD PRIME STUD
4@3.77 15.08
084305355546 HOMER BUCKET <A>
5 GAL BUCKET-HOMER LOGO (ORANGE)
5@3.25 16.25
764666177536 8D HOT GLV1B <A>
8D 2-1/2"HOT GALV S/T PATIO DECK 1#
2@5.38 10.76
073257012874 POLY SHEET <A> 22.98
10'X25' 6MIL CLEAR POLY SHEETING
0000-193-828 ABS PIPE <A> 18.25
3" X 10' ABS-DWV PE PIPE

SUBTOTAL 83.32
SALES TAX 7.46
TOTAL $90.78
XXXXXXXXXXXX8312 VISA
USD$ 90.78
AUTH CODE 09157B/2010515 TA
Chip Read
AID A0000000031010 Visa Credit
TVR 8080008000
IAD 06010A03608000
TSI 6800
ARC 00

0482 01 65936 01/26/2018 0903

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HTJ 132643 132162

Password:
18076 132161

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Page 1 of 1

Figure 4: Receipt for 2 in. x 4 in. Wood Stud and 5 Gallon Buckets


See back of receipt for your chance
to win $1000

ID #: 7M2B37DQPY9

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Save money. Live better.
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MANAGER JENNIFER FOSTER
2750 S WOODLANDS VILLAGE BLVD
FLAGSTAFF AZ 86001
ST# 01175 OP# 009048 TE# 48 TR# 08743
BANDS 64-40Z 007181506648 1.27 X
MENS CREW 009056349622 19.93 X
SUBTOTAL 21.20
TAX 1 8.951 % 1.90
TOTAL 23.10
VISA TEND 23.10
Visa Credit **** **** **** 8312 I 1
APPROVAL # 02213B
REF # 803300019108
TRANS ID - 588033693017027
VALIDATION - BTLW
PAYMENT SERVICE - E

AID A0000000031010
TC 58D8C1C2974450DE
TERMINAL # SC010354
*NO SIGNATURE REQUIRED

02/02/18 12:15:11
CHANGE DUE 0.00
ITEMS SOLD 2
TC# 2240 6025 8901 9856 9626

Low Prices You Can Trust. Every Day.
02/02/18 12:15:11
CUSTOMER COPY

Use Walmart Pay to save your receipts.

Figure 5: Receipt for 100% Cotton T-Shirts

amazon.com

Final Details for Order #112-7510650-5429807

Print this page for your records.

Order Placed: February 22, 2018
Amazon.com order number: 112-7510650-5429807
Order Total: $90.00

Shipped on February 23, 2018

Items Ordered	**Price**
2 of: *Deionization Resin Mixed Bed 5 Lb Bag* Sold by: Windows101 (seller profile) Condition: New	$45.00

Shipping Address:
Cameron Rhodes
1385 W UNIVERSITY AVE # 06-142
FLAGSTAFF, AZ 86001-7131
United States

Shipping Speed:
Standard Shipping

Item(s) Subtotal:	$90.00
Shipping & Handling:	$0.00

Total before tax:	$90.00
Sales Tax:	$0.00

Total for This Shipment:	**$90.00**

Payment information

Payment Method:
Visa | Last digits: 8312

Billing address
Cameron Rhodes
1385 W UNIVERSITY AVE # 06-142
FLAGSTAFF, AZ 86001-7131
United States

Item(s) Subtotal:	$90.00
Shipping & Handling:	$0.00

Total before tax:	$90.00
Estimated tax to be collected:	$0.00

Grand Total:	**$90.00**

Credit Card transactions Visa ending in 8312: February 23, 2018: $90.00

To view the status of your order, return to Order Summary.

Figure 6: Receipt for Ion-Exchange Resin

/11/2018 Amazon.com - Order 114-1110892-9525019

amazon.com

Details for Order #114-1110892-9525019

Print this page for your records.

Order Placed: March 11, 2018
Amazon.com order number: 114-1110892-9525019
Order Total: $33.98

Preparing for Shipment

Items Ordered	**Price**
2 of: *39 Ounce Premium Laboratory Grade Super Activated Carbon with Free Media Bag Inside* Sold by: Encompass All (seller profile) Condition: New	$16.99

Shipping Address:
Cameron Rhodes
1385 W UNIVERSITY AVE # 06-142
FLAGSTAFF, AZ 86001-7131
United States

Shipping Speed:
Two-Day Shipping

Item(s) Subtotal: $33.98
Shipping & Handling: $0.00

Total before tax: $33.98
Sales Tax: $0.00

Total for This Shipment: $33.98

Payment information

Payment Method:
Visa | Last digits: 8312

Billing address
Cameron Rhodes
1385 W UNIVERSITY AVE # 06-142
FLAGSTAFF, AZ 86001-7131
United States

Item(s) Subtotal: $33.98
Shipping & Handling: $0.00

Total before tax: $33.98
Estimated tax to be collected: $0.00

Grand Total: $33.98

To view the status of your order, return to Order Summary.

Figure 7: Receipt for Granular Activated Carbon

3/11/2018 Amazon.com - Order 114-3781160-1533851

amazon.com

Details for Order #114-3781160-1533851

Print this page for your records.

Order Placed: March 11, 2018
Amazon.com order number: 114-3781160-1533851
Order Total: $8.87

Preparing for Shipment

Items Ordered	**Price**
1 of: *Clorox Regular Bleach, 30 Ounces* Sold by: Amazon.com Services, Inc. Condition: New	$8.14

Shipping Address:
Cameron Rhodes
1385 W UNIVERSITY AVE # 06-142
FLAGSTAFF, AZ 86001-7131
United States

Shipping Speed:
Two-Day Shipping

Item(s) Subtotal: $8.14
Shipping & Handling: $0.00

Total before tax: $8.14
Sales Tax: $0.73

Total for This Shipment: $8.87

Payment information

Payment Method:
Visa | Last digits: 8312

Billing address
Cameron Rhodes
1385 W UNIVERSITY AVE # 06-142
FLAGSTAFF, AZ 86001-7131
United States

Item(s) Subtotal: $8.14
Shipping & Handling: $0.00

Total before tax: $8.14
Estimated tax to be collected: $0.73

Grand Total: $8.87

To view the status of your order, return to Order Summary.

Figure 8: Receipt for Clorox Bleach

amazon.com

Details for Order #112-5381264-5698647

Print this page for your records.

Order Placed: March 13, 2018
Amazon.com order number: 112-5381264-5698647
Order Total: $28.41

Not Yet Shipped

Items Ordered	Price
1 of: *HTH 61308 Pool Filter Sand, 50-Pound* Sold by: MaxWarehouse (seller profile) Condition: New	$28.41

Shipping Address:
Cameron Rhodes
2091 N 133RD CIR
GOODYEAR, AZ 85395-2153
United States

Shipping Speed:
Standard Shipping

Payment information

Payment Method:
Visa | Last digits: 8312

Billing address
Cameron Rhodes
1385 W UNIVERSITY AVE # 06-142
FLAGSTAFF, AZ 86001-7131
United States

Item(s) Subtotal:	$28.41
Shipping & Handling:	$0.00

Total before tax:	$28.41
Estimated tax to be collected:	$0.00

Grand Total:	**$28.41**

To view the status of your order, return to Order Summary.

Figure 9: Receipt for Sand