Minimizing the Ecological Footprint of a Nature Resort

Abstract

River Kwai Park & Resort is located in Chongsadao, Kanchanaburi, a province in Thailand. Our sponsor, the resort owner, aims to reduce waste of plastic water bottles by installing a water purification system at the resort. We distributed a survey to the staff and based on responses we created a behavior change plan to encourage staff to drink purified water. The behavior plan revolves around motivation, mentors, and incentives. We recommended two water purifier options based on size, cost, and performance. As the hospitality industry is responsible for a large share of global waste and has an ever growing ecological footprint, implementing sustainable waste management and reduction practices at the resort can set an example of how these issues can be addressed.

RIVER KWAI
PARK & RESORT
ศูนย์กลิกรรมธรรมชาติ เคเอสแอล ริเวอร์แคว

River Kwai Park & Resort

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Chula Chulalongkorn University

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WPI

Team Members

Jane Spear

Elise Nerden

Evan Rios

Poomipat Laorsatiankul

Bunnasorn Kaenrattana

Vipakkapond Sakyapinan

Woranuntha Varavarn na Ayudhaya

Advisors

Professor Holly Ault, WPI

Professor Stephan Sturm, WPI

Professor Supawan Tantayanon, CU

Professor Siripastr Jayanta, CU

Professor Numpon Insin, CU

Sponsor

River Kwai park & Resort

C Term 2022

Waste Reduction at River Kwai Park & Resort

The hospitality industry is responsible for 9% of all the world's waste.[1] To be a successful tourist destination, the guests must be pleased with their experience, but because this is the industry's main concern, resorts have not adjusted to more environmentally friendly practices. Plastics are a major contributor to the world's waste problem. Plastic releases greenhouse gasses at every stage of production, contributing to global warming.[2] Plastic also breaks down into microplastics, negatively affecting the environment and seeping into water supplies.[2] Sustainable methods such as composting or reducing the use of single-use plastics are only starting to be incorporated into the hospitality industry. Implementing these environmentally sustainable practices can benefit the tourism industry and simultaneously bring awareness to the ongoing battle of pollution and climate change.[3]

River Kwai Park & Resort, shown in Figure 1, is located in Chongsadao, Kanchanaburi, a rural town in Thailand. The primary industry in Kanchanaburi is tourism, with many resorts on the Khwae Yai River (also known as Kwai River). The owner of the River Kwai Park & Resort wants to reduce its ecological footprint. Initiatives of new sustainable waste disposal practices such as composting and extensive recycling were implemented in October 2021 at the resort.

The next step that the sponsor wishes to take at their resort is to reduce plastic waste. One of the largest causes of plastic waste at the resort is the use of plastic water bottles due to the scarcity of clean potable water within the area. The sponsor wishes to reduce plastic waste by installing a water filtration and purification system and motivating the staff to stop using disposable water bottles.

The project goal was to develop a behavioral plan and recommend a water purification system to reduce plastic waste at the River Kwai Park & Resort. To complete the project goal four objectives were determined:

Figure 1. This is River Kwai Park & Resort in Kanchanaburi, Thailand.

1. **Understand the current waste generation and waste management at River Kwai Park & Resort**
2. **Identify the values and sustainable habits of the River Kwai Park & Resort staff**
3. **Provide a behavioral analysis of the resort staff and a behavioral plan to motivate the staff to stop using plastic water bottles**
4. **Evaluate water filtration and purification systems and recommend a system to produce drinkable water from the Khwae Yai River**

To accomplish these objectives and the project goal, we conducted interviews, a survey, and research to understand the waste management at the resort and the best ways to improve it. We used the information from these methods to develop suggestions and deliverables for our sponsor, including water purifier recommendations, a behavioral change plan, and an infographic for the staff.

Environmental Laws & Policies, Plastic Pollution Impact, and Waste Management in Kanchanaburi

To understand the resort's waste management and opportunities for waste reduction, extensive research was necessary. Topics such as the resort itself, waste management in Thailand, global pollution, and the theory of behavior change were important to fully understand our project. These topics provide context about what solutions are possible, given the existing policies in Thailand and what resources are available for waste management around the resort. The global issue of pollution and poor waste management practices emphasizes the importance of this project. Understanding the staff's behavior when implementing changes is crucial to maximize environmental change.

River Kwai Park & Resort

River Kwai Park & Resort is located in Kanchanaburi, which is Northwest of the capital, Bangkok (see Figure 2).

River Kwai Park & Resort is a subsidiary of KSL Group (Khon Kaen Sugar Industry Public Company Limited) which has a vision of environmentally sustainable practices along with business stability. Under new ownership since 2021, the resort management established new policies to mitigate the waste management problems in the resort. In August of 2021, the staff attended a training program (conducted by Less Plastic Thailand) to learn about waste separation and (plastic waste) reduction. The staff began to separate waste at the resort and sold plastic waste with proceeds going towards bonuses. Food waste was fed to livestock at the resort. The owner established these policies and also trained their employees to understand sustainable waste management to motivate them to change their lifestyles.

Figure 2. Map with the Kanchanaburi province (highlighted in red). Kanchanaburi is where River Kwai Park & Resort is located.[4]

Thailand's Sufficiency Economy Philosophy

Thailand's laws, policies, and governmental initiatives relating to environmental protection have become more prevalent in recent years. Many of these laws and policies are influenced by Thai King Rama IX's sufficiency economy philosophy.[5] This philosophy was created to help poor citizens in rural areas who were struggling to provide resources for themselves due to unsustainable farming techniques. The sufficiency economy philosophy is based on reasonableness and moderation to create self-immunity. Reasonableness and moderation outline that people should decide what materials they actually need and only produce or use what is needed, which also reduces waste. This self-evaluation and type of decision-making lead to self-immunity, which means that communities, and Thailand, will not have to rely on other areas or countries for resources.[6] This philosophy is prevalent in Thailand's environmental protection laws and policies today and is relevant to the environmentally sustainable practices that our sponsor wants to incorporate at the resort.

Impact of Plastic Waste

Single-use plastics have a detrimental effect on the environment, human health, and wildlife. Single-use plastics are mainly made from petrochemicals that are fossil fuel-based. Plastics never break down, and instead, break up into small particles called microplastics. Microplastics get into water supplies, affect wildlife, and are even ingested by humans. When microplastics break down they also release chemicals that can result in health problems including (but not limited to): hormone imbalances, fertility issues, and an increased risk of cancer.[2]

Impact of Recycling Plastic Waste

Plastic can only be recycled a maximum of one or two times. Each time plastic is reused it also degrades, losing some of its materials

properties. Plastic is expensive and time-consuming to sort due to the number of types. In 2018, less than 10% of the plastic used in the United States was recycled. Although recycling is more ecologically friendly than waste going to landfills or being incinerated, it is less environmentally friendly than reducing the amount of waste created.[7]

Although the recycling industry does have issues, recycling has the possibility to have a major impact on plastic waste by reducing it. However, there is still the problem that plastic can only be recycled a few times before becoming too brittle to be recycled. Figure 3 shows that the volume of recycled plastic is even more than waste being generated over the years. Although recycling is important, the reduction should be the first and foremost goal.

The resort's main production of plastic waste is from water bottles that contain water used for drinking and cooking. Currently, the resort sells its used plastic to private contractors for monetary gain, but the owner wants to remove the need for plastic water bottles entirely. Implementing sustainable habits and a reliable water purification system could reduce plastic waste.

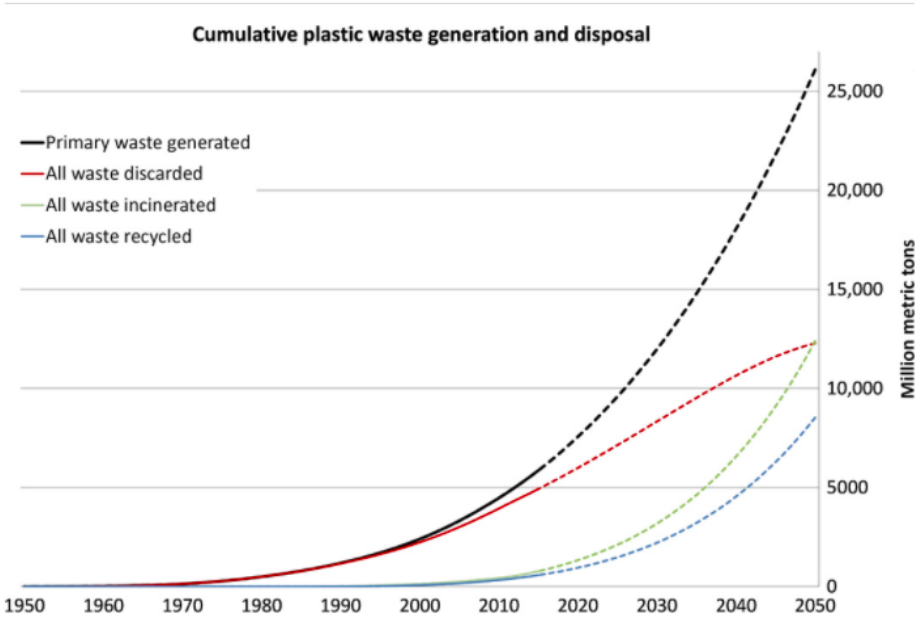

Figure 3. Global cumulative plastic waste generation and disposal (in million metric tons). Solid lines show historical data from 1950 to 2015; dashed lines show projections of historical trends to 2050.[8]

Impact of Water Purification and Filtration Systems

Water purification and filtration systems allow individuals to drink tap water without concerns about illness or unpleasant taste. The purpose of water filtration is to remove any solute or organic materials that are potentially polluting the source of water.[9] Water purification systems use reverse osmosis to provide safe and healthy drinkable water by removing microorganisms and chemical contaminants. To remove any chemicals polluting the water source, flocculation or chlorination is needed through water purification. These processes clean the polluted water of any contaminants or microbes to prevent disease.[10]

Water from the Khwae Yai River shown in Figure 4, is only used for cleaning and bathing at the resort, but with the production of potable water, bottled water would no longer be necessary for drinking and cooking at the resort.

Although plastic water bottles can be recycled, the collection and transportation of those recycled plastics require more energy consumption than water filtration systems and produce greenhouse gasses.[12] Plastic water bottles are also an added cost for the resort staff, and access to clean water would allow them to save money. If River Kwai Park & Resort implemented a purification and filtration system it would allow staff and guests to reduce their plastic waste.

Process of Behavioral and Environmental Change

Adopting sustainable practices is a process that is not easy for communities to quickly adapt to. Factors such as governmental, societal, cultural, and educational are considered during a process of change. National government support is important during a transition from unsustainable to sustainable waste management practices because they can provide resources to communities to make a transition possible. In many countries, a lack of government structure and support in environmental issues has been shown to constrain sustainable development.[13] Support and resources from the government are needed to help communities start and follow through with the change.

Figure 4. Khwae Yai River located in Kanchanaburi. The Khwae Yai River flows along River Kwai Park & Resort.[11]

To suggest a successful waste reduction system to be integrated into the Kanchanaburi community, cultural and societal impacts need to be considered. The community's values and thoughts towards a situation are important to consider when implementing change. Respecting their culture and considering their thoughts will help develop a plan that the community is willing to participate in.

Education is also important when implementing a plan for change in a community. Education helps community members understand the importance of the problem that is trying to be solved. Training from educational organizations such as Less Plastic Thailand (reference section "Less Plastic Thailand Training" for more information) about plastic pollution and waste management is important, however, programs about waste reduction are equally if not more impactful.

Considering this background knowledge, implementing a behavior plan will be helpful when transitioning from bottled water to filtered water. Transitioning from bottled water to filtered water is a change that some individuals could have reservations or fear about. When switching to filtered water it is important that there is trust in the system, and that the resort staff understands the filtration and purification processes. To do this our group researched and used Prochaska's Transtheoretical Model to understand what behavior changes were necessary to make this change. Prochaska's Transtheoretical Model is a model that explains the change in behavior and is commonly used for situations such as individuals working on addiction.

Prochaska's Transtheoretical Model

Prochaska's Transtheoretical Model of Change (TTM) contains five stages of change which are: Precontemplation, Contemplation, Preparation, Action, and Maintenance, as shown in Figure 5. These stages outline a person's thought process through deciding to change and enacting that change.[14] Behavior change can take over two years, and an individual needs to take their time through each stage to make sure the final stage (Maintenance) is reached and effective in the long term.[15] These stages may also be cycled through before reaching the Maintenance stage since people sometimes revert back to their natural behavior before implementing new habits for the long term.[14]

The Precontemplation stage means that someone has not thought of the issue of interest or changed their behavior at all. The individual sees no need to change their behavior or does not know that they can change their behavior because they do not know the problem exists. The Contemplation stage means that the individual has been introduced to the issue and the option to change their behavior. The individual is considering change by weighing its benefits and drawbacks.

The Preparation stage (also sometimes referred to as the determination stage) happens once the individual has decided to change and is getting ready to enact that change. This is when the individual is developing a plan to successfully change.

The Action stage is when the individual is changing their behavior. They are developing new habits and consciously choosing to not act on their natural habits.

The Maintenance stage is when the individual is continually behaving with their new habits and is choosing to avoid reverting back to their former habits. Maintenance is one of the most important stages, since if the behavior change is not practiced regularly or for an extended period of time (at least six months), then the change is not fully incorporated into their everyday life.[14]

Less Plastic Thailand Training

Less Plastic Thailand is a non-profit organization based in Bangkok that serves organizations and provides general education nationwide in Thailand. Their main goal is to educate people about the harm plastic pollution has on the environment and how to reduce and recycle plastic. Waste separation is one of their biggest focuses by educating individuals how to properly recycle plastic. Less Plastic Thailand provides plans for businesses and individuals about how to reduce plastic waste in their day-to-day lives. Reusable accessories such as containers and straws are also suggested to reduce plastic waste from the source.[16]

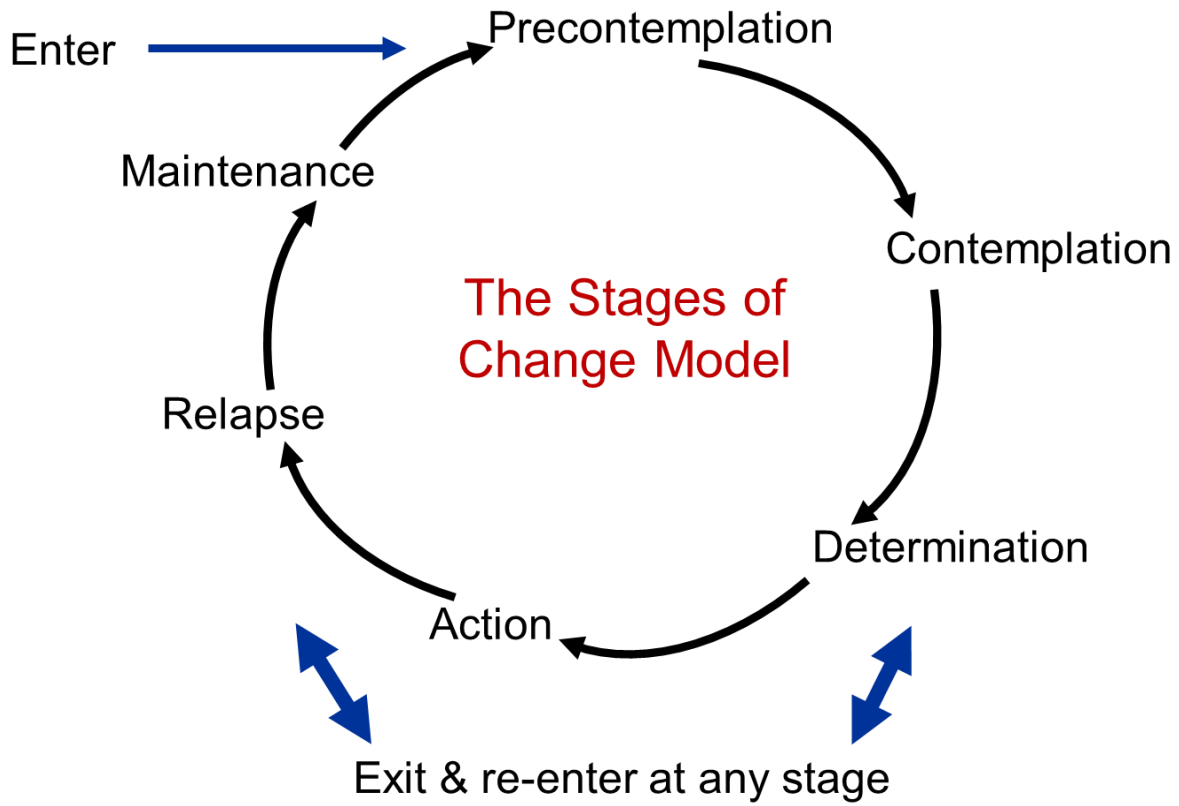

Figure 5. The stages in Prochaska's Transtheoretical Model (TTM).[14]

Reducing Plastic Waste at the River Kwai Park & Resort

River Kwai Park & Resort is located among one of the most precious sites rich in natural resources in Kanchanaburi. The resort has adopted green initiatives in many aspects, however, there is still room for improvement. The primary goal of this project is the reduction of plastics at River Kwai Park & Resort. A water purification system would give the staff the ability to not be required to drink bottled water. A behavioral plan was designed to fully understand what actions need to be done to motivate the staff to reduce their single-use plastics and incorporate this habit into their daily lives. To accomplish this, the team studied, investigated, and analyzed the problems that the resort staff and owner were facing. Former studies involving sustainable waste removal models in the ecotourism industry were investigated. Conversations and feedback were also received from the sponsor throughout the project. Overall, the methodology comprised of four objectives:

1. **Understand the current waste generation and waste management at River Kwai Park & Resort**
2. **Identify the values and sustainable habits of the River Kwai Park & Resort staff**
3. **Provide a behavioral analysis of the resort staff and a behavioral plan to motivate the staff to stop using plastic water bottles**
4. **Evaluate water filtration and purification systems and recommend a system to produce drinkable water from the Khwae Yai River**

We aimed to change the staff's behavior to use reusable water bottles and drink filtered and purified water instead of using disposable plastic bottles. Site visits helped provide the contextual understanding of factors affecting the applicability of our projects such as land limitation, surrounding natural resources of Kanchanaburi, the resort appearance, and the workplace culture at the resort. To establish a suitable plastic waste reduction framework, the team explored the history of waste management at the resort and the surrounding community. Interviewing the owner and resort staff about their general understanding and conceptual framework of waste management helped us understand how we could formulate a plan to reduce plastic waste at River Kwai Park & Resort.

The Resort Owner Values the Environment

Throughout the project, the team consulted with our sponsor, the River Kwai Park & Resort owner. The owner values the environment and influences the resort staff to incorporate sustainable habits into their personal lives. She expressed the desire to reduce plastic waste, specifically plastic water bottles at the resort. In the past year, the owner implemented a new waste management plan that composted organic waste, recycled plastic waste, and properly dealt with hazardous waste. The issue that waste was burned and buried behind the resort (believed to either be due to the staff or the villagers) was also stopped (Figure 6 shows the previous burn pile). In short, there were two missions the sponsor wanted the team to address:

1. **The resort staff drink from disposable plastic water bottles due to the undrinkable tap (river) water.**
2. **The owner initially acknowledged that because of the lack of awareness of sustainable waste management, the staff could not separate or dispose of waste appropriately. The owner wanted to help them adjust their mindsets and behaviors. The owner wants to motivate the staff to stop drinking water from disposable water bottles once a filtration and purification system is implemented.**

Staff Experience with the Current Waste Management of the Resort

The resort has recently implemented a more environmentally friendly waste management system (see Figure 7 and Figure 8). Food waste is used for animal feeding. The plastic disposable water bottles are sold to the private garbage truck as an additional income. The majority of the staff agreed that the money earned from selling plastic waste is the motivation for them to carry out the waste separation. The training by Less Plastic Thailand has also encouraged the staff to participate in the new waste management system. The rest of the waste is forwarded to the weekly state garbage truck. One of the staff stated that waste separation has gradually been incorporated into their daily habits.

The staff of the River Kwai Park & Resort were surveyed to understand their way of life and mindset about waste management. Their daily life shows their intentions, motivations, and daily habits. Each staff member has a different role or duty in the resort community. Learning about the staff and each individual's role at the resort is important for understanding the staff's involvement with the current waste management system. Furthermore, the staff's values, habits, and opinions helped the team design an effective behavioral change plan since behavior change depends on individuals' values.[15]

Behavioral Analysis of the Resort Staff

The team developed a questionnaire for the staff using a Likert Scale, ranking answers of respondents to statements given on a scale of one to five (see the Supplementary materials section for this survey). These questions were designed to help determine what stage of change the staff falls under on Prochaska's Transtheoretical Model of Change (TTM).[14] Eighteen out of the total of 32 staff members completed the survey. Each Likert Scale answer corresponds with a specific TTM stage. Each survey question or statement is assigned a weight between one and three when calculating the change stage of each staff member. The higher the weight number, the more important the question is when determining the change stage each staff member is in for reducing their plastic waste. The responses along with the weights of the questions were compiled in ways that best represent the staffs' standings in the TTM. Based on those standings, we were able to form a behavioral change plan for the staff to adjust their behavior to use fewer disposable plastic water bottles.

Figure 6. Previous burn pile behind River *Kwai Park & Resort.*

Figure 7. Some of the bins for waste separation at the resort.

Figure 8. Food waste used to feed animals on the resort property.

Data from Staff Surveys

The weighting of the questions can be seen in Table 1 where questions that are more influential are weighted higher (a scale of three). The questions that were weighted as most important (three) were graphed based on the distribution of the responses.

Table 1. The thirteen survey questions given to the staff with the corresponding weighting of the questions when regarding the importance of the TTM stages of change. The weighting was based on a scale-out of three: three being the most important when calculating the TTM stages, and one being the least important.

Question or Statement	Weight
I try to reduce my plastic waste at home	2
I try to reduce my plastic waste at work	2
I think about the effect plastic has on the environment	2
I drink out of plastic water bottles	2
I would drink filtered and purified river water if it was provided	3
I think about climate change	2
I think recycling makes a positive impact on the environment	1
I think composting makes a positive impact on the environment	1
How do you feel about changes the new manager has made for the resort…	1
I carry around a reusable water bottle	3
I think the Mab Aung Natural Agricultural Center is helpful when addressing environmental issues	1
How often do you think about your personal impact on the environment?	2
Protecting the environment is one of my top values	3

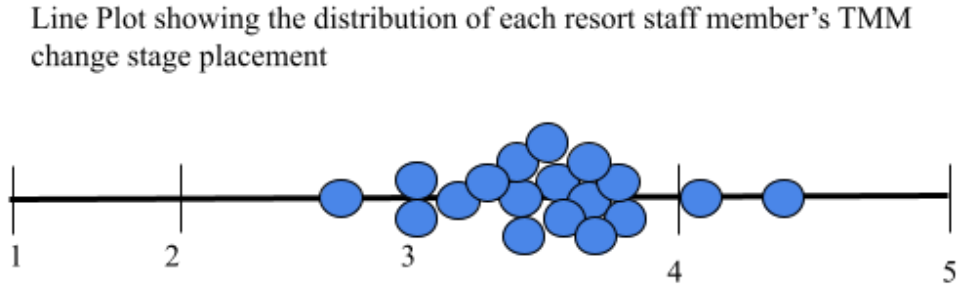

Figure 9. Line Plot displaying the calculated distribution of resort staff on TTM stages of change placement. Total of eighteen staff responded to the survey.

Staff Survey Results Analysis

Eighteen of River Kwai Park & Resort staff responded to the survey. The staff are clustered between stages 3 (preparation) and 4 (action). Figure 9 shows the distribution of the staff member's and where each is in the TTM stages of change. It shows that most staff members are approaching the Action stage, showing that they are preparing to begin to change and start to incorporate more sustainable habits into their everyday life. Figure 12 shows that the staff values protecting the environment and is mainly in the Action stage. Many staff are in the preparation stage with respect to carrying reusable water bottles (Figure 11). The statement asking if the staff would drink purified water at the resort if provided is in between stages Preparation and Action (Figure 10).

The staff is in the Action stage of Prochaska's Transtheoretical Model; however, they have not begun to change because the staff does not have the ability to change. Figure 6 demonstrates that the staff has a will to change and value the environment and reduce their plastic waste. To provide the staff with the ability to change, a purification system must be implemented to access drinkable water.

Water Filtration System

The sponsor of the River Kwai Park & Resort requested recommendations for a water purification system for the resort. Specifications for water purification systems include the incoming and outgoing water, the capacity, and the power supply. The regulations on filtered water include physical quality, chemical quality, and limits on microorganism content. These criteria were used to research water filtration systems for the resort.

In Figure 13, the construction plan for the water filtration system that will be implemented in the future at River Kwai Park & Resort can be seen. There are four steps in the filtration system, each outlined in Figure 13. A cost analysis of the implementation of a water purification system was outlined for the sponsor. Three purification systems were compared, based on the specifications of the sponsor.

Quality of Khwae Yai River

As of early 2021, the water quality index (WQI) was considered good for the Khwae Yai River, which indicates it is in a range of 71-90 on a scale from 1-100.[17] WQI is determined by evaluating Dissolved Oxygen (DO), pH, total dissolved solids, hardness, calcium, magnesium, total alkalinity, and electrical conductivity (Regional Environment office 8th Ratchaburi, 2020).[18] Table 2 shows other characteristics of the Khwae Yai River.

Needs Assessment for the Water Filtration System

The water filtration system will filter water from the Khwae Yai River running alongside River Kwai Park & Resort. The Khwae Yai River originates in Tak province in the Thanon Thong Chai range and flows South to Kanchanaburi. Throughout the lower part of the river where the resort is concerned, there are five water quality monitoring stations.

The needed drinking water in a month is approximately 30 tanks (each being 20 liters) for staff. Taking into account guests required an additional 10 tanks per month. Therefore, the minimum drinking water needed is around 1000 liters each month.

The purification systems have standard criteria for feeding water in order to extend the life of machines. Table 13 shows the specific criteria of feed water.

Referencing Tables 2 and 3, it can be seen that the criteria for the water purification systems are met with the data that we have for the Khwae Yai River. If we had time to continue working on this project, the team would test the water from the Khwae Yai River to further confirm that it meets the above criteria. If these criteria are not met, the Khwae Yai River may not be an option as a drinking source. At that point, other water sources would be considered when implementing a filtration and purification system.

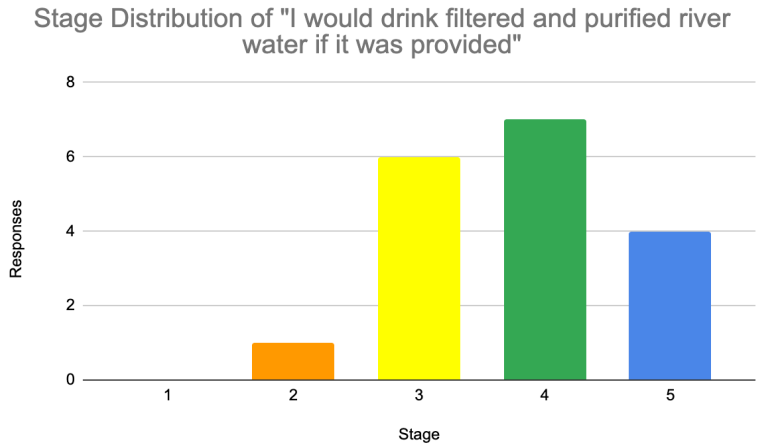

Figure 10. Transtheoretical Model change stage distribution of the survey statement "I would drink filtered and purified river water if it was provided." Most of the responses to this statement reside in stage 3 (Preparation) and stage 4 (Action), corresponding with neutral and agreed responses, respectively.

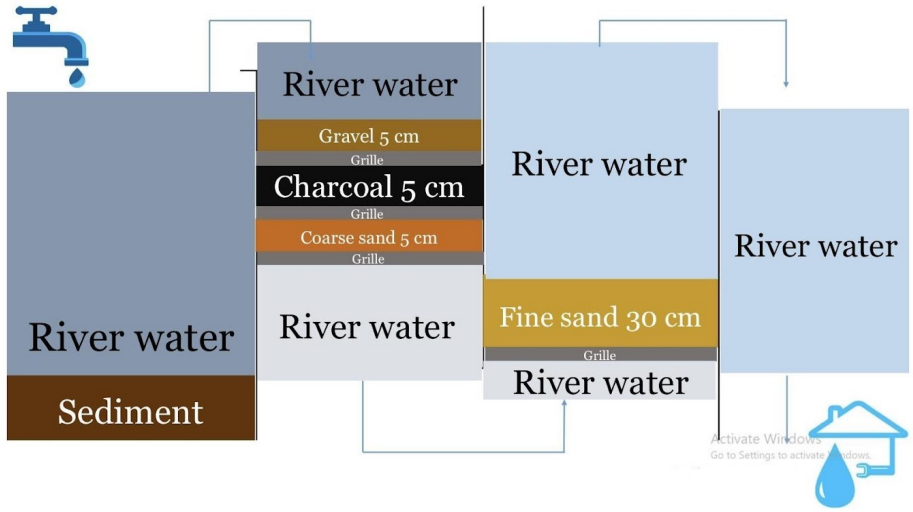

Figure 13. Constructed plan for water filtration system at River Kwai Park & Resort.

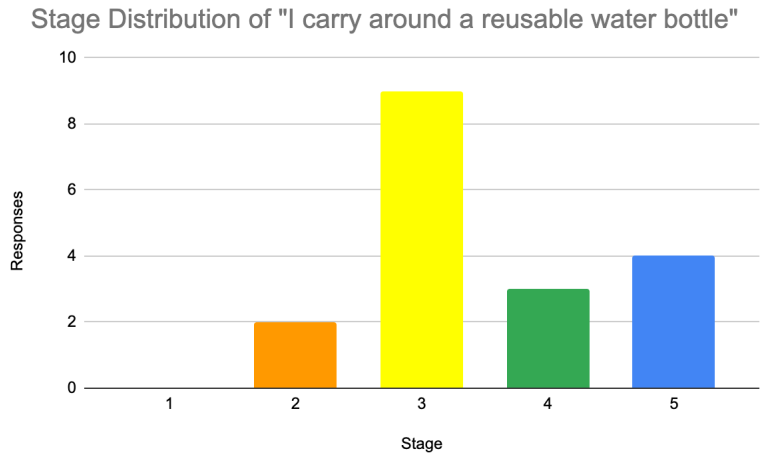

Figure 11. Transtheoretical Model change stage distribution of the survey statement "I carry a reusable water bottle." The majority of the responses to this statement reside in stage 3 (Preparation), which corresponded with the response sometimes.

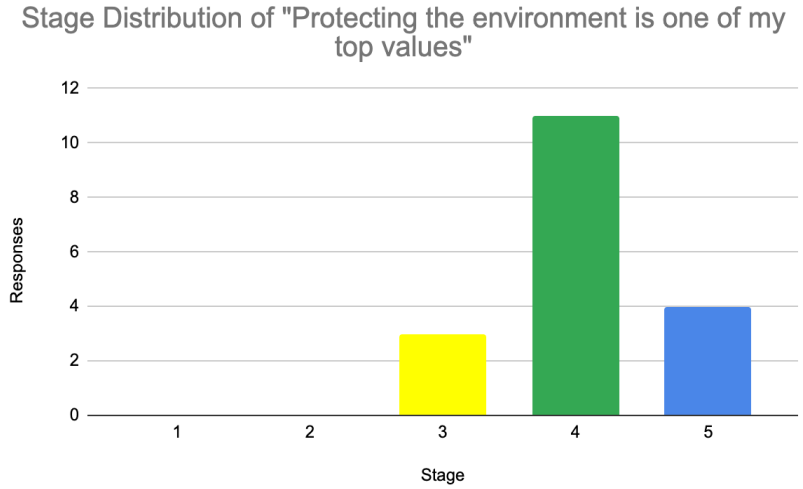

Figure 12. Transtheoretical Model change stage distribution of the survey statement "Protecting the environment is one of my top values." Most of the responses to this statement reside in stage 4 (Action), which corresponded with the response 'Agree'.

Table 2. Water quality of Khwae Yai River according to different metrics.[19]

Characteristic	Value
Dissolved Oxygen (DO) (mg/l)	6.0
Biological Oxygen Demand (BOD) (mg/l)	1.1
1,2,4-trichlorobenzene (TCB) (ppm)	11,000
Fecal Coliform Bacteria (FCB) (MPN/100 ml)	170
Ammoniacal-nitrogen (NH3-N) (mg/l)	0.23
Turbidity (NTU)	7.45
Salinity (g/l)	0.11
pH	7.72
Total Dissolved Solids (TDS) (mg/l)	155
Water Quality Index (WQI)	71-90

Recommended Water Purification Systems

From all water purification systems distributed in Thailand we chose three for further analysis and comparison: Treatton RO, the Makitis RO, STIEBEL ELTRON "Glacier" RO. These three systems were the only ones that satisfied the resort owners requirements on the amount of water they filter and cost. Table 4 shows the key characteristics of each water purification system, namely dimension, cost, capacity, power supply, and the number of purification steps of each selected purifier.

Table 3. Criteria of different characteristics of feed water

Characteristic	Limit
Feedwater pressure (bar)	2-3
Total Dissolved Solids (TDS) (mg/l)	< 500
Hardness (mg/l)	< 50
Iron (mg/l)	< 0.05
Calcium (mg/l)	< 0.1
Turbidity (NTU)	< 1
Silt density index (SDI)	< 5
pH	3-10
Temperature (°C)	5-45

3.4.4 Design of Decision Matrix

We created a decision matrix to compare the different options based on the criteria requested by the resorts' owner to evaluate the best option: size, cost, capacity, the lifetime of filter, cost of filter, and performance. Each filter was scored for each criterion out of a scale of three, with a score of three the most desirable outcome and a score of one the least desirable. The team decided to double the weight of the performance criterion based on the number of purification steps, as the safety of the drinking water has the highest priority. The total score for each filter was then calculated by adding the scores of the different criteria. In this way, the filter with the highest

Table 4. Dimension, cost, capacity, power supply, purification steps, lifetime of the filter and cost of the filter, the Treatton RO, MAKITIS RO, and STIEBEL ELTRON "Glacier" RO water purifiers.[20]

	Dimension (cm)	Cost (Baht)	Capacity (liter/ day)	Power Supply (V)	Purific-ation Steps	Lifetime of Filter (months)	Cost of Filter (Baht/year)
Treatton RO	40 x 22 x 80	25,000	2000	220	5	6-12	5,000 - 7,000
MAKITIS RO	90 x 60 x 190	35,000	2000	220	6	6-12	5,000 - 7,000
STIEBEL ELTRON "Glacier" RO	50.2 x 37 x 45	20,990	2500	100-240	3	8	6,810

score is the one to be recommended for River Kwai Park & Resort.

It is important to note that the three analyzed filters' power supply requirements were all very similar, if not the same. The Treatton RO water purifier and the MAKITIS RO water purification system with a fiber tank require a power supply of 220 Volts. The STIEBEL ELTRON "Glacier" RO water purification system has a power supply of 100-240 Volts, which overall is very similar to the other two. This means that all the systems work around that world that use 100V and 220V electricity, so parts replacement would be easily accessible. Since the STIEBEL ELTRON requires a power supply within a specified range, it is difficult to compare to the other two that do not accommodate a range of power supply.

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Decision Matrix Scoring Criteria

Cost:
- 1 > 30,000 baht
- 20,000 baht < 2 < 30,000 baht
- 3 < 20,000 baht

Capacity:
- 3 > 2000 liters per day
- 1000 < 2 < 2000 liters per day
- 1 < 1000 liters per day

Area:
- 1 > 50 x 50 cm
- 25x 25 cm < 2 < 50 x 50 cm
- 3 < 25 x 25 cm

Lifetime of Filter:
- 3 > 12 month
- 6 < 2 < 12 month
- 1 < 6 month

Cost of Filter:
- 3 < 5,000 baht/year
- 5000 < 2 < 10,000 baht/ year
- 1 > 10,000 baht/year

Performance:
- 6 > 5 purification steps
- 3 steps < 4 < 5 purification steps
- 2 3 purification steps

Capacity Criteria note:
Machines can work usually three to four hours continuously, but a longer operation may cause an overload in the filtration system. The capacity criterion of 1000-2000 liters water filtered per day is based on hypothetical calculations if the filtration system would run 24 hours continuously. This criterion is based on the amount the sponsor requested to account for the guests and staff drinking the purified water in the future .

* The machines have similar processes that the number of purification processes can compare.

Performance Criteria notes:
The performance criterion is based on the number of steps in the purification process.

	Size	Cost	Performance	Total Score
Treatton RO water purifier	2	2	4	15
MAKITIS RO water purification system with Fiber tank	1	1	6	15
STIEBEL ELTRON "Glacier" RO water purification system	2	2	2	13

Table 5. Decision matrix comparing purifiers, based on: size, cost, capacity, performance, lifetime of the filter, and cost of the filter. Each criterion is scored on a scale of three, three being the most desirable. The performance criteria were weighted by a value of two, having a total score out of six. The total score is added for each filter. *The capacity, lifetime of filter and cost of filter all have the same score for each purifier. Those scores are three, two, and two respectively.

Decision Matrix & Analysis

Referencing Table 5 it can be seen that the Treatton RO water purifier and MAKITIS RO water purification system with Fiber tank have the highest score out of the three being analyzed. The STIEBEL ELTRON water purifier has the lowest score.

River Kwai Park & Resort Recommendations for Plastic Reduction

Recommended Behavioral Change Plan

The behavioral change plan was based on Prochaska's Transtheoretical Model. Most of the staff fall between the Preparation and Action stages. Our plan focuses on the transitions from Preparation to Action and Action to Maintenance. However, guidance on transitioning for the other change stages is given since some of the staff may cycle back to the previous stages. Reference Figure 14 for an overview of recommendations for each TTM stage based on findings in the previous chapter.

Precontemplation to Contemplation:

To reach the Contemplation stage, the staff needs to become aware of the issue of plastic waste and its impact on the environment. For the staff to begin to understand the impact of their actions, understanding this issue on a global scale is imperative. The staff has received some education about plastic waste management and reduction (from Less Plastic Thailand) but this needs to be continued to convince the staff to motivate the staff to change. The owner and

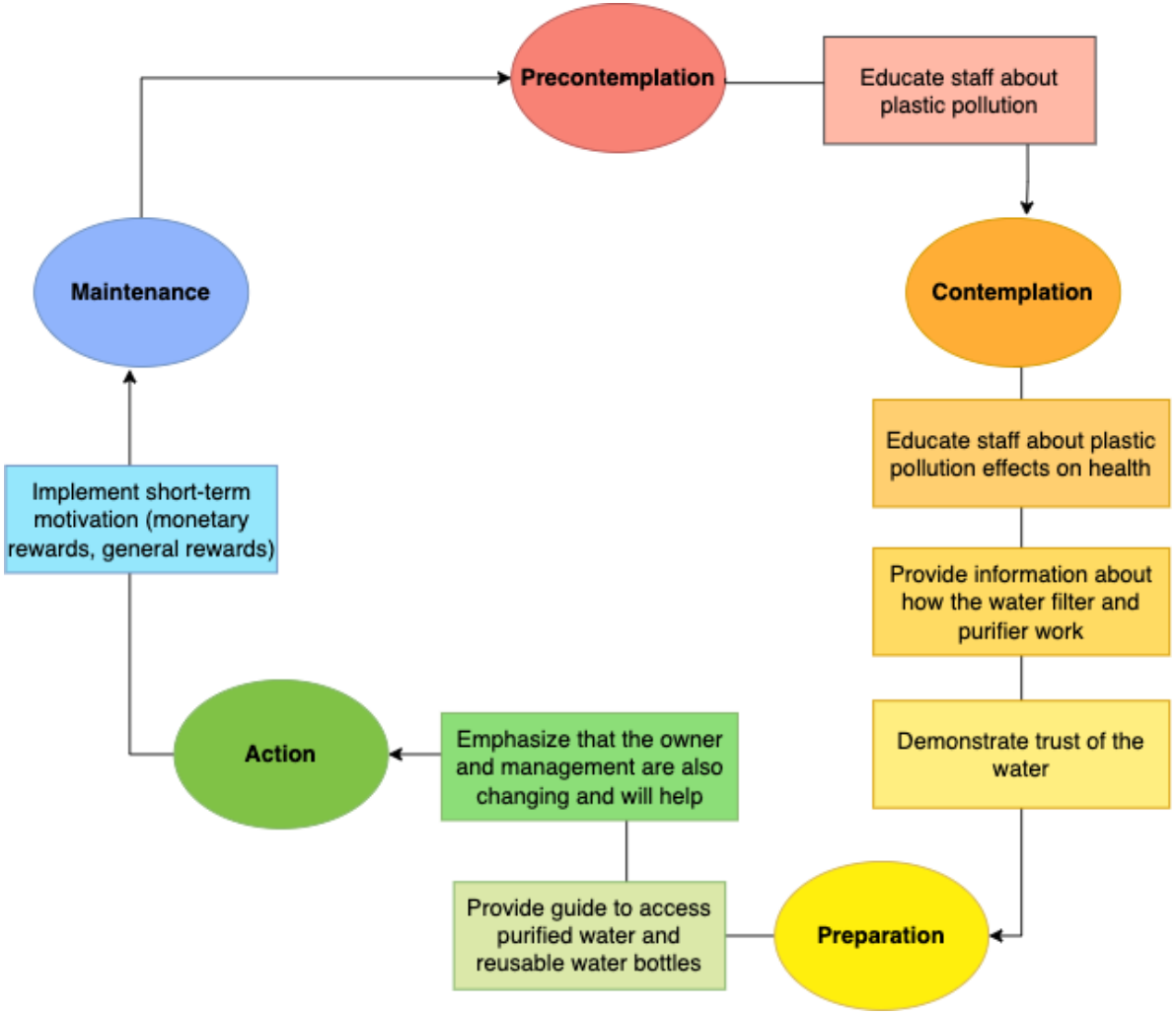

Figure 14. Diagram about how the resort owner and management can help the staff progress to the next desired stage in the TTM to reduce plastic waste. Resort staff should transition from using disposable water bottles to reusable water bottles, using filtered and purified water. Each of these steps will be executed verbally, in writing, and through graphics to make the information accessible to all of the staff.

managers can educate the staff about the impact of plastic pollution through the information provided by the Less Plastic Thailand training and information from our background research in this report. The main goal is to get the staff who are in the Precontemplation phase to understand that plastic pollution is detrimental to the environment, and since the River Kwai Park & Resort is a nature resort, is also important to the resort owner's values.

Contemplation to Preparation:

Once a staff member understands the impact of plastic pollution and considers change, the transition to the Preparation stage should begin. To transition from Contemplation to Preparation, forming an emotional connection and aligning values with the issue is important since behavior is value based.[15] Something that is important to many people is their health and their loved ones' health. The owner and managers should provide the staff with information showing that plastic pollution not only harms the environment, but also harms human health through environmental contamination and global warming.[2]

The staff also need to trust the purified water, so information about why the water is clean needs to be provided. See Figure 15 for the infographic we created to educate the staff on the filtration and purification processes. This infographic will be posted at the water refill station once it is installed, so that the staff can see what processes the river water goes through to make it safe to drink. We created a graphical representation of the filtration and purification processes since most of the staff do not have scientific backgrounds and some are illiterate. The infographic was made to be easily understandable. The owner and managers should build trust with the staff by also drinking the purified water.

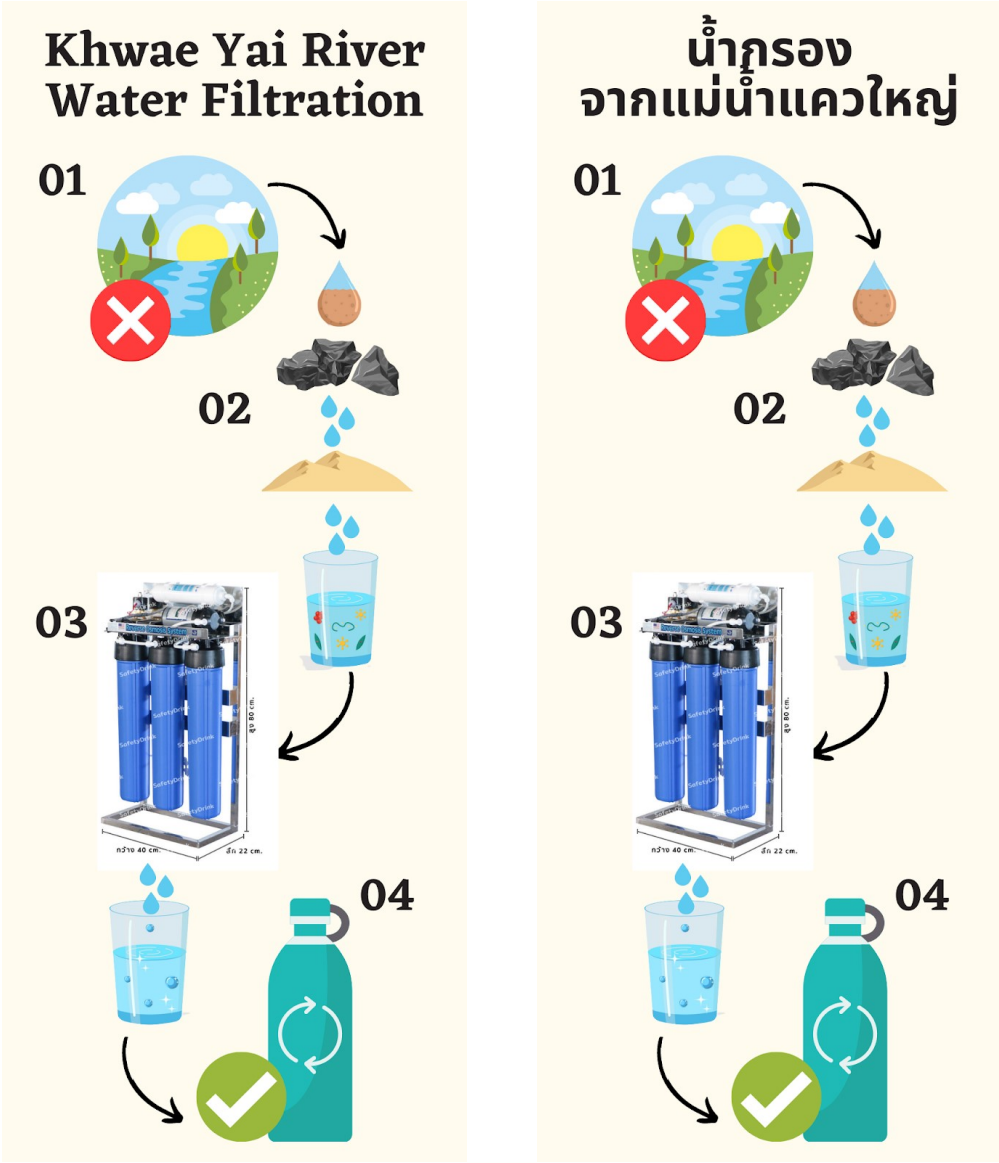

Figure 15. Infographic to educate River Kwai Park & Resort staff about the water filtration and purification processes. The infographic is shown in both English and Thai.

Preparation to Action:

When the staff are in the Preparation stage, that means they are preparing to drink purified water and using reusable water bottles. To reach the Action stage, a plan needs to be provided to the staff to give them the *ability* to change. This plan will include information of where to access the purified water, such as a map, and where to get reusable water bottles at the resort. At this point, the owner and managers should emphasize again that they will also be going through this change, and if the staff needs any help with this transition or understanding anything they will be available. This should make the staff feel secure in their decision to change their behavior and know what is coming next when they reach the Action stage.

Action to Maintenance:

When the staff have reached the Action stage, they will be using reusable water bottles to drink purified river water. To help the staff reach the Maintenance stage, there needs to be motivation for them to keep these new behaviors. Short-term motivation such as monetary rewards or other incentives is helpful to solidify the habit of drinking purified water. These monetary rewards and incentives could include a bonus or more days off for keeping new behaviors for a certain period of time.

To gauge where the staff is on the TTM along the way, the owner and managers should get input from the staff. Ask them how they feel about drinking purified water and their opinions on the issue of plastic pollution. Then, the owner and managers know which steps to take with which staff members. Some staff members may cycle through the TTM multiple times, which is normal since changing behavior is against natural habits. In this case, continue the steps throughout the cycle to help them change their habits.

Staff Recommendations to Improve the Waste Management System at the Resort

When interviewing the staff, they had suggestions to improve the current waste management system at the resort. The staff stated that color sorting durable bins with waste pictures should guide the illiterate staff or anyone unfamiliar with the waste separation rules. The resort resides on a sizable amount of land. The staff mentioned that they wanted more waste separation stations to cover the resort's working areas to simplify the separation process. This suggestion could help shorten the time consumed transporting waste within the resort. The staff also suggested that implementing guest waste separation stations would be helpful as the staff currently separates the guest's waste. Another suggestion was to implement a punishment for staff using plastic water bottles or not separating waste properly such as a fine to motivate change and effectiveness. The staff also wants a role model to establish easy waste separation and disposal methods.

Recommended Water Filtration System

The recommended water filtration system outlined in 3.5 is the Treatton RO water purifier or the MAKITIS RO water purification system with a Fiber tank that received the highest scores in the decision matrix. The decision matrix compares the three selected purification systems based on six characteristics: size, cost, capacity, performance, the lifetime of the filter, and cost of the filter (Table 6).

Conclusion

The recommendations for River Kwai Park & Resort revolve around reducing plastic waste. Plastic water bottles are responsible for a large portion of plastic waste at the resort. The main contributor to this is the fact that there is not a source of drinking water at the resort. The recommendations include water purification systems as well as a behavior plan. The behavior plan suggests methods the management can use at the resort to motivate their staff to reduce their use of plastics and drink filtered water instead of bottled water. Reducing the use of disposable plastic water bottles, which reduces plastic waste, is an important part of reducing the resort's ecological footprint and helping the environment.

Supplemental materials for this project can be found at:

www.eprojects.wpi.edu

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