Improving Visitor Experiences and Water Quality in Ugra National Park, Kaluga

Worcester Polytechnic Institute • Interactive Qualifying Project

Submitted to:

Professor Svetlana Nikitina

Submitted by:

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Improving Visitor Experiences and Water Quality in Ugra National Park, Kaluga

Interactive Qualifying Project Report completed in partial fulfillment of the Bachelor of Science degree at
Worcester Polytechnic Institute, Worcester, MA

Submitted To

Professor Svetlana Nikitina

In Cooperation With
Ugra National Park

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Professor Svetlana Nikitina

Abstract

This project focused on Ugra National Park in the Kaluga region of Russia, which needed help in increasing its visibility to tourists and protecting its river from industrial pollution. To investigate possible contamination, the team took water samples along the river and analyzed them for two different types of paper factory byproducts. Negative results showed that alternative hypotheses and tests for other contaminants are needed. In order to increase the park's tourism the team conducted on-site research of the visitor accommodations and services. Comparing Ugra to other parks prompted the team to recommend adding more signs, indicating historic sites and creating a public outreach campaign. These measures will attract more tourists to see the park's historic and natural treasures.

Acknowledgements

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Chapter One – Introduction

In a world so focused on technology, national parks are a safe haven away from all the buzzing, ringing and messaging of today's society. They give people a place to re-group and enjoy the beauty of a natural landscape. Therefore, keeping these places intact and accessible to visitors is the primary goal of the rangers that patrol the national park. Of the forty-one parks scattered throughout Russia's vast countryside, this project focused on Ugra National Park because its rangers requested help with issues in the preservation and accessibility of the park (UNESCO, 2012). It was the aspiration of the sponsors that the park was to be cleaned of waste and that its tourism was to be increased. Their park deserves to be clean and seen by as many people as possible. It is a beautiful place full of lakes, rivers, forests and woodland animals. Its trails lead to expansive vistas with views of the lovely Ugra River and should be revered for its majesty. By reviewing the park in person and comparing the strengths and weaknesses to national parks of the United States, this project proposed recommendations to help the park clean up its magnificent river and to create the perfect environment for visitors of all kinds.

The park was established to protect the land inhabited by endangered animals and to offer a place for "eco-tourism and recreation" (The Ministry of Natural Resources and Environment of the Russian Federation, 2013b). While this is the goal of the park, currently there are multiple accounts of insolent behavior towards the grounds in the form of littering and abuse of its waterways. For instance, the park rangers believe there is chemical contamination in the river which could be due to human interference. There is also a shortage of visitors to the park that can be contributed to the current mindset of a significant portion of the Russian public. One of

the rangers at the park and also a sponsor of this project, Tatiana Gordeyeva, mentioned that she believed that most Russians do not regard national parks as an asset to the country but rather as a drain on land that could be built on. She suggested that since the Russian Federation has so much land that people assume they have nature to spare and that it does not need to be taken care of. To help this park reach its full potential and attract more tourists the contamination needed to be stopped, the park had to be improved as far as accommodations for visitors and the public opinion towards the national park had to be improved (Gordeyeva, 2013).

Stopping the contamination started with determining what was being pumped into the water. The best method of proceeding with this was to collect comparative data samples along the river and analyze the results. Before the start of this project, the park rangers had analyzed chemical data but did not have enough evidence to consider their findings conclusive. To find definitive proof of contamination, samples were taken from multiple points before and after suspicious tributaries merged with the Ugra River. The boat taken to these different sites was covered with signs and flags of the organization to help bring attention to our venture. The ultimate goal was to raise awareness and educate people to respect their environment. When the public supports the park it would be much easier to contain industrial dumping by both legal and moral means.

According to the park's environmental lawyer, the best way for legal action is with the backing of the Russian people. Yuri Kazannikov mentioned that in most cases without substantial evidence, national parks have a hard time prosecuting violators. If there is too little evidence to convict the suspected violators, there is still a possibility to resolve the damage that they created. In a city called Yuknov, dirty water was reportedly leaking into the Ugra River and

tainting it. The local media covered this incident and since it received so much attention the leakage was stopped (Kazannikov, 2013).

While this instance did get a lot of notoriety, usually the public is not on the side of the national park. The park rangers mentioned that most of the society believes that the national parks are holding them back in terms of expansion of cities and development of industry. The public is not wrong on this behalf; the national park has successfully fought off factories that try to settle on the park grounds. What they do not see however is that preserving the land is more important than yet another automobile factory in the area. Their anti-park attitude might come from the idea that Russia has vast amounts of sprawling countryside in every direction and doesn't need conservation. There needs to be a change in outlook towards the park if it hopes to gain complete backing by the community.

Switching the perspective of the society would also help with the other goal of increasing the number of tourists visiting the park. While the park is only a few hours' drive from the capital city of Moscow, few people make the excursion out to see the riverside vistas. Besides sentiments towards it, this could be because of two problems the park has: lack of adequate signage and a disinterest on the part of the public due to a lack of knowledge of the park and due to an absence of amenities needed for a comfortable excursion. An easy fix to this first problem is to simply add more signs to make the park and its trails easier to find. However, this solution may not help to inspire people to visit. Even the most helpful signs are useless if there is no one to read them. The public has to want to come to this park and that starts with educating the public about its wonderful natural beauty, historic importance and inspiring art instillations. Teaching about these attractions as well as the protected animal habitats could help people understand that the park is something to visit and venerate rather than ignore and pollute.

Chapter Two – Background

2.1 Introduction

In order to effectively help the national park, an overall understanding of the area is needed. This information will help with the two goals of the project, namely, helping the park with water pollution and increasing tourism. Since it is thought that the Ugra River is contaminated it is important to know how the park can go about trying to remedy this. Because of its status as a biosphere reserve, Ugra should have the backing of the Russian Federal Government if there is in fact pollution. Looking into past problems and how other parks dealt with the situation will map out how Ugra's supposed problem can be fixed. As far as getting visitors to come to the park, this starts with understanding the features that it has to offer such as history and animal life. This basic information can really help to lay a good foundation for the project.

2.2 Establishment of Biosphere

Ugra National Park was initially founded to preserve the river basin area surrounding the Ugra River in 1997 and was selected as the 30th Russian park to be granted protection as a biosphere reserve in 2002. A biosphere is a national park that allows for economic and population growth by permitting citizens to live and thrive within its boundaries. Ugra was established as such by the worldwide Man and Biosphere Programme (MAB) sponsored by the United Nations Educational, Scientific and Cultural Organization (UNESCO). MAB is "an Intergovernmental Scientific Programme aiming to set a scientific basis for the improvement of

the relationships between people and their environment globally" (UNESCO, 2013b).

According to the National Park Service, most biospheres are separated into three areas:

1. A central "core" area which serves as a refugium for plant and animal communities and their genetic resources. A core area has secure legal protection and permits scientific research on how biological diversity can be sustained.
2. A "buffer zone" surrounding the core area which may include experimental research and rehabilitation, and accommodate education, tourism and recreational facilities. Manipulative management practices are permitted to enhance production while conserving natural processes.
3. A "transition" area surrounding the other zones where concepts developed in the reserve are applied to achieve sustainable balances between the use of natural resources to meet human needs and their conservation for the future of the entire region. (National Park Service, 2013)

The majority of the population usually resides within this last section, the transition area; in Ugra there are about 2,500 people (UNESCO, 2012).

While allowing inhabitants does mean that a biosphere, as compared to a national park, has more relaxed guidelines and restrictions there are still laws to protect Ugra's animal and plant populations and its grounds. The park uses this power when it feels like anything under its protection is being threatened. In previous cases, the park has charged people with crimes against the park in order to defend its territory.

2.3 Importance of Biosphere

2.3.1 Animal Life

The work that Ugra National Park does with animals is awe-inspiring. It is definitely a feature that needs to be shown to the public to indicate to them how truly important the park is as a whole. While most citizens believe that national parks blocks progress but what it actually blocks is animal extinction.

Being a biosphere reserve empowers Ugra National Park to protect animal and plant populations that reside within its borders. It is its main goal of the national park to keep all the animals safe and healthy; this is a difficult task as some of the animals on their territory are on what is known as "The Red List". Complied by the International Union for Conservation of Nature, The ICUN Red List of Threatened Species™ files animals under different categories in terms of how endangered they are. On this list, the Russian Desman is categorized as being vulnerable. This means that it "is facing a high risk of extinction in the wild in the medium-term future" (The IUCN Red List of Threatened Species, 2013). As a State Party to the policies of the IUCN, the Russian Federation places a strong emphasis on biodiversity conservation and tries to protect this wildlife as best as possible. The biosphere accreditation allows for Ugra to protect this Desman, its Important Bird Areas (IBAs) as well as its old-growth broadleaf woodlands all of which deserve and need strong protection (UNESCO, 2013a). The public needs to see that these areas need to be protected and that the national park is irreplaceable in this feat. Showing them this idea should prove that the national park is not a nuisance but a valuable part of the area (The IUCN Red List of Threatened Species, 2008).

2.3.2 History of the Area

Currently, the park has some signs around its trails that denote the historical importance around the area. These facts are interesting and a great addition to the scenic aspect of the park, however not all of the history is covered. There are very important battles, fronts, and uprisings that happened in the Ugra area but most are not labeled. The historical information below can be added to these signs to better convey a holistic view of the park's past.

While the national park itself is very young, the importance of its land in Russian history started long before the park was inaugurated. One of the most significant events in the history of

Ugra was the stand against the Tartar oppression. In 1480, the citizens refused to pay tribute to the Tartars. The khan of the Great Horde, Akhmat, led his troops to Moscow to force the people to pay. At the mouth of the Ugra River, Akmat was stopped by Russian forces that blocked every overpass. To cross, Akhmat started a bloody battle that lasted days. The Russians held their ground and repelled the Tartar force. The Tartars retreated to the Luza River where they were confronted by the army of Ivan III on the opposite side of the bank. This marked the beginning of "The great stand on the Ugra River (Yeltsin Presidential Library, 2009).

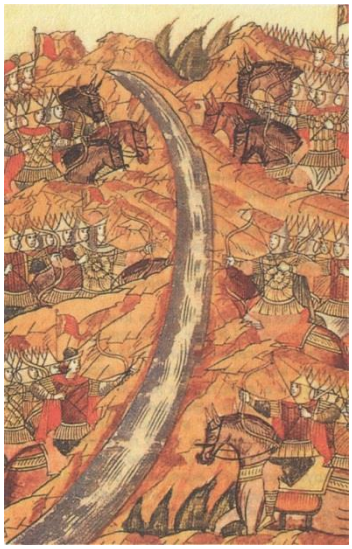


Figure 1: "A European painting from 1480 depicting the Great Stand on the Ugra River" (Map Walk, 2013).

With the unsuccessful negotiations between Ivan III and the khan Akhmat, the former moved his forces to the town of Borovsk gaining the rear behind the Tartar forces. On November 11, 1480 khan Akhmat ordered his troops to retreat. Three months later in the first month of the new year, the Tartar force met the army of a Siberian khan Ibak and in the battles between the two forces khan Akhmat was killed. With a vacuum of power within the ranks of the Tartar forces, the militia split into many separate forces known as khanates. While the Russian state fought through the 16-18th centuries with these khanates, the true war was already

over. Their individual strengths could not weaken the sovereignty of the great state and as such "The great stand on the Ugra River" is considered to mark the end of the Tartar yoke (Yeltsin Presidential Library, 2009). All of the current signs in the national park deal with the history of World War II while none depict the sacrifice of these battles. The fights at the Ugra River might not have ended the Tartar yoke but it is still a significant achievement and should be documented along the river.

Several hundred years after the fall of the Tartars, the Ugra Front once again played a pivotal role, this time in World War II. The park tries very hard to maintain the evidence left behind by these great battles. Reconstructed trenches and bunkers are preserved in the park a well as two war memorial paths that have been constructed to honor the losses that the Russian Federation suffered on the banks of the Ugra River. These paths commemorate the times when the Russian army was able to come out ahead of the Nazis and gain ground.

The Pavlovasky and Sukovskiy Foothold Paths runs were the Germans built their fortifications on the bank in 1941 (IUEC, 2013b). The Nazi regime wanted to seize this territory in order to move into Moscow but was stalled significantly by the Russians. Both Stalin and Hitler were constantly updated about the situation on the Ugra Front because of its immense importance to the continuation of the war. Until the defeat at Stalingrad forced the recall of Nazi forces, the Ugra Front was constantly in battle and a total of 2,300 Soviet soldiers lost their lives there. While these two paths do have good information they are not enough to show the significance of the Ugra Front. The history of the Ugra area is vast and inspirational, however it is not being used affectively to portray the significance of the park (IUEC, 2013a).

2.4 Possible Routes of Contamination

2.4.1 Paper Plants and Sewage

Currently, the park rangers of Ugra suspect that the river is being contaminated by illegal waste that has been dumped on a regular basis by companies and individuals. The park rangers have noticed a decrease in the overall quality of the water (Grishenkov, 2013). They believe that paper factories that lie on tributaries of the river are unknowingly releasing contamination. Any dumping of "waste and drainage water into water bodies (with the exception of dumping treated water through special deep-sea editions), as well as other water uses that adversely affect health and ecological condition of these facilities" is illegal (Specially Protected Natural Territories of The Russian Federation). Under the Russian Federation federal law regulations, the waters of this park are heavily protected however, since it is a biosphere, Ugra River is a much harder water source to police and protect (Kazannikov, 2013). Since the supposed waste sites are actually off the reserve land it is also very difficult to prosecute the people who might be polluting. The park rangers believe that paper factories and leaky sewage systems are possible contaminators of the Ugra River. On tributaries of the river, there are institutions such as Polotnyano Factory Paper Mill and Tzoitsk Paper Factory that could be contributing chemicals or waste into the river. There is no data that shows the paper plants are contaminating the river, this information is coming only from the thoughts of the park rangers. There are many different contaminants that could be infiltrating the river besides the paper factories, however. To verify that there is contamination and exactly what type it is, it is important to understand what kinds of material would be found in the river with each kind of pollution.

2.4.2 Agricultural Waste

One of the other types of contamination that concerns the park rangers is agricultural runoff. Since Ugra is a biosphere reserve, there are people who live off their land and are well within their rights to maintain farms and practice agriculture. The problem evolves when this farming creates unwanted waste that, if not treated or removed properly, can contaminate the nearby waterways. This is usually more of an issue with animal farms as the animals can produce noxious waste. In the area around Ugra River, however, grain production is the primary agricultural activity. Farms producing wheat and barley do not produce nearly as much waste as animal farms and what they do produce, the material called "chaff," is biodegradable. There is a chance that the methods of farming, involving the use of pesticides could be harmful toward the environment. This would be hard to test for specifically because of the sheer number of different pesticide types. Avgust, Russia's largest manufacturer has over 60 different disinfectants, herbicides, fungicides and insecticides to sell (avgust, 2013). While this would be incredibly difficult to test for, to find animal waste a simple *E. coli* test could be used (*E. coli* will be defined in the following section).

2.4.3 Effect of Animal or Human Waste on the Water

Farms and sewage drainage would both cause fecal matter to end up in the river which can end up being deadly. All mammals use bacteria commonly referred to as *E. coli* in their lower intestine but when the bacteria of a foreign entity are ingested the effects on humans are devastating. While these bacteria can be harmful, it is in fact a needed and necessary part of the intestinal tract. They "can help digestion processes, food breakdown and absorption, and vitamin K production" (MicrobeWiki, 2013). Even though *E. coli* is important to digestion, the problem occurs when foreign *E coli* somehow gets in. Most infections occur from eating food or drinking

water that has been in contact with fecal matter and not properly sterilized. The infected often display symptoms of "severe stomach cramps, diarrhea (often bloody), and vomiting" (Center for Disease Control, 2013a). Depending on the person, the contamination could change between completely harmless to lethal. The percent of people who die from infection is very low, much lower than another possible contaminant of *Vibrio cholera* (Center for Disease Control, 2013a).

The ingestion of the bacteria *Vibrio cholera* can cause the intestinal illness Cholera that is very painful and can ultimately lead to death if untreated. People become infected through the intake of contaminated water and quickly start to exhibit symptoms including over-production of sweat, fever and painful diarrhea. This diarrhea is usually a milky white and very thin in consistency. People become dehydrated at an alarming rate due to extreme water loss caused by the diarrhea. The cure is simple: hydrate. However, if the water source is the point of contamination there is little hope in it becoming better anytime soon. If the water in Ugra is contaminated with *Vibrio cholera* then there is a high likelihood that some type of sewage is infiltrating the waterways. As of now there are only inklings that either of these two pollutants could be in the Ugra River as there is no real evidence (Center for Disease Control, 2013b).

2.4.4 What Paper Waste Contamination Means for the Water

The worst of the potential offenders in terms of water quality could be the paper companies on the outskirts of the Ugra territory. The Trinity and Kondrovskaya Paper Companies are not located within the property of the Ugra biosphere reserve, however, they are situated near tributaries that lead into the park. This can be seen in the following picture:

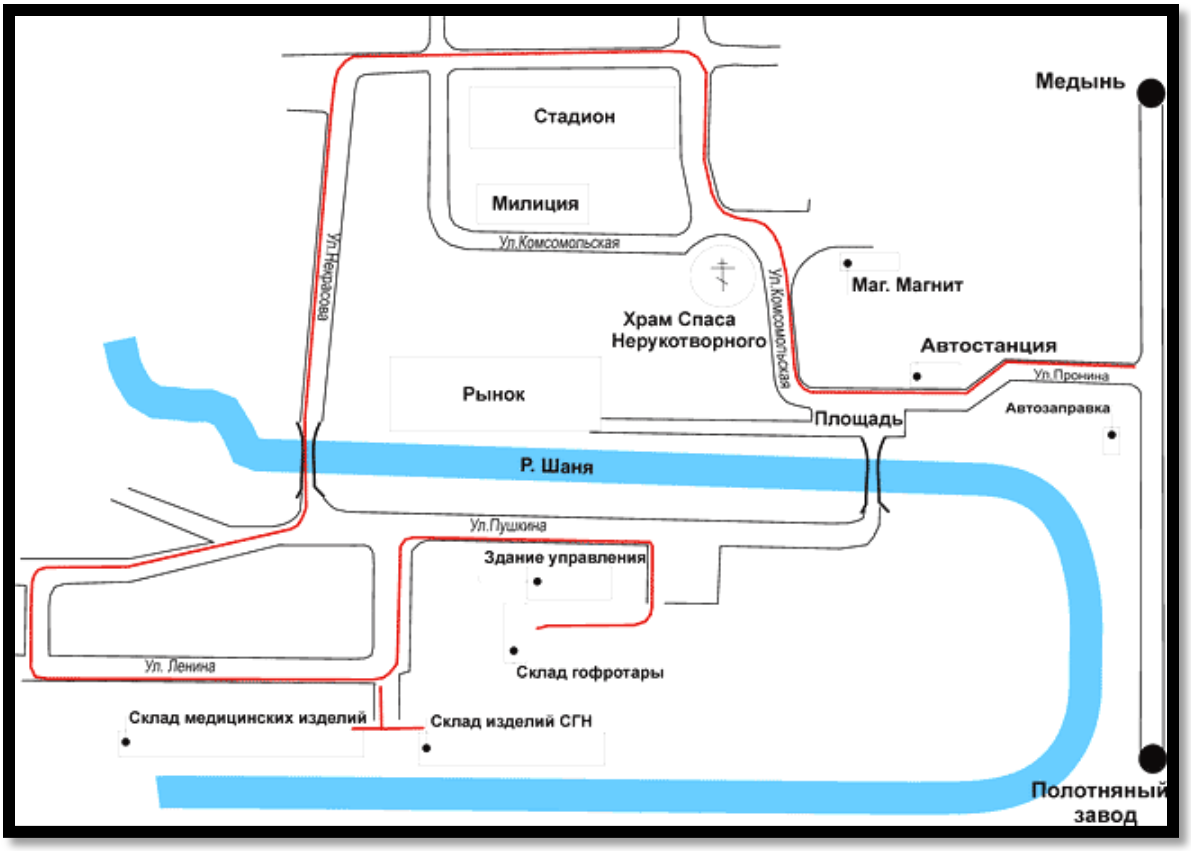


Figure 2: Aerial View of Kondrovskaya and one of the Ugra Tributaries running through it (Kondrosvskaya, 2013).

Since these companies do not fall within the jurisdiction of the biosphere reserve, even if they are contaminating the water they are not technically breaking the law and would be hard to pursue. However, the chemicals from the plant still could be getting into the protected waterways of the park. If it were found that these chemicals are getting into the park, it would take the public's help to bring the contamination to a stop. Looking at the map below, it is apparent that the cities are close to each other and that the runoff could easily be the cause of the supposed contamination in Ugra. Kaluga, where the park is located, is circled in purple; Condravo, written in red, is where the paper companies are situated; given for reference purposes, Moscow is shown and circled in blue.

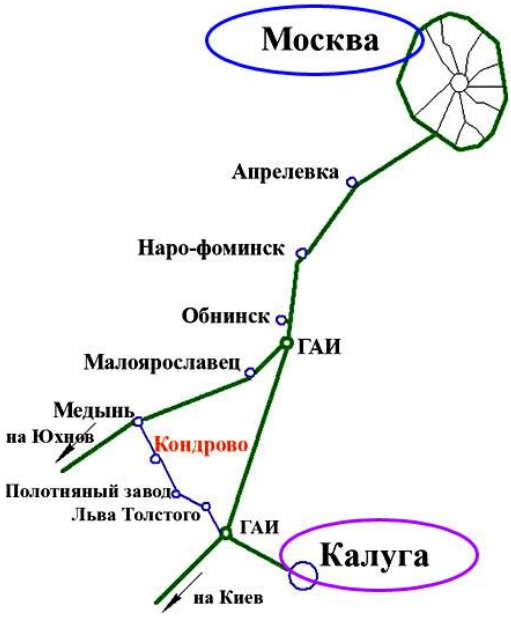


Figure 3: Map of the distal relations of the park (purple circle), the paper factories (red) and Moscow (blue circle) (Kondrosvskaya, 2013).

If these factories are disposing of waste into the river, there could be potentially harmful chemicals seeping into the water. To produce paper, the wood must be ground into a thin pulp and then bleached heavily. Both these two products can be harmful to the environment. It might seem contradictory that the natural substance of wood would be bad for the river, but in large quantities it can disrupt the delicate balance of the ecosystem. Biodegradable substances like wood require bacteria in the deterioration process (Pritchard, 2013). Too much wood in the river would cause a significant increase in these bacteria which expel carbon dioxide, CO_2; once released into the water, CO_2 reacts to change into H_2CO_3 or carbonic acid. This can greatly increase the acidity of the river water, lowering its pH levels. According to the data from Ugra, the pH is a bit higher than normal which may indicate that there is not much of this type of contamination present. However, this could also be because the second by-product of the factory is swaying the pH towards the basic end of the spectrum. Bleach is an extremely basic solution

that would increase the pH balance of the river. Whatever the contamination is and wherever it is from, it needs to be stopped and removed from the water (Plummer, 2013).

2.5 Previously Recorded Data

Since 1938, Ugra National Park has kept detailed records of the water analyses preformed on site. Obtaining this information is the first link in the chain of actions of trying to figure out the nature of the contamination. The data show information of the water in the following categories: O_2, pH, Ca, Mg, Na+Ka, HCO_3, SO_4, Cl, NO_3, NO_2, PO_4, Si and Fe. These data points allow for understanding of the water contamination. For example, the pH levels can indicate if the river is too acidic or alkaline. The correct average pH without contamination should roughly be around 7.0. The next two charts reflect the pH balance data from 1938 to 1969 and then again from 2001-2007.

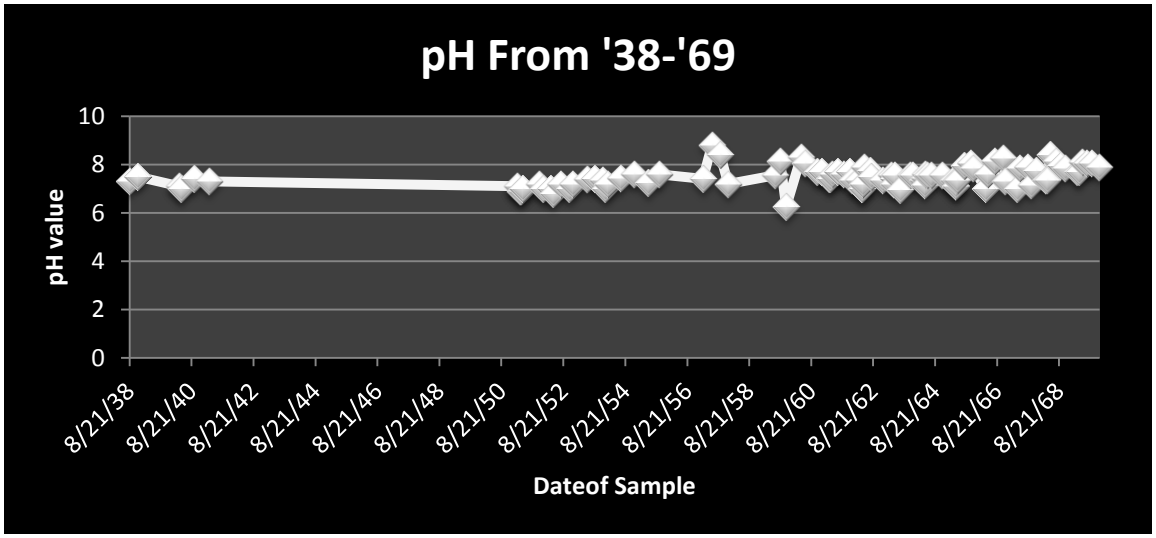


Chart 1: A line graph displaying the linear quality of the pH levels in the Ugra River from 1938 to 1969 (Ugra National Park, 2013).

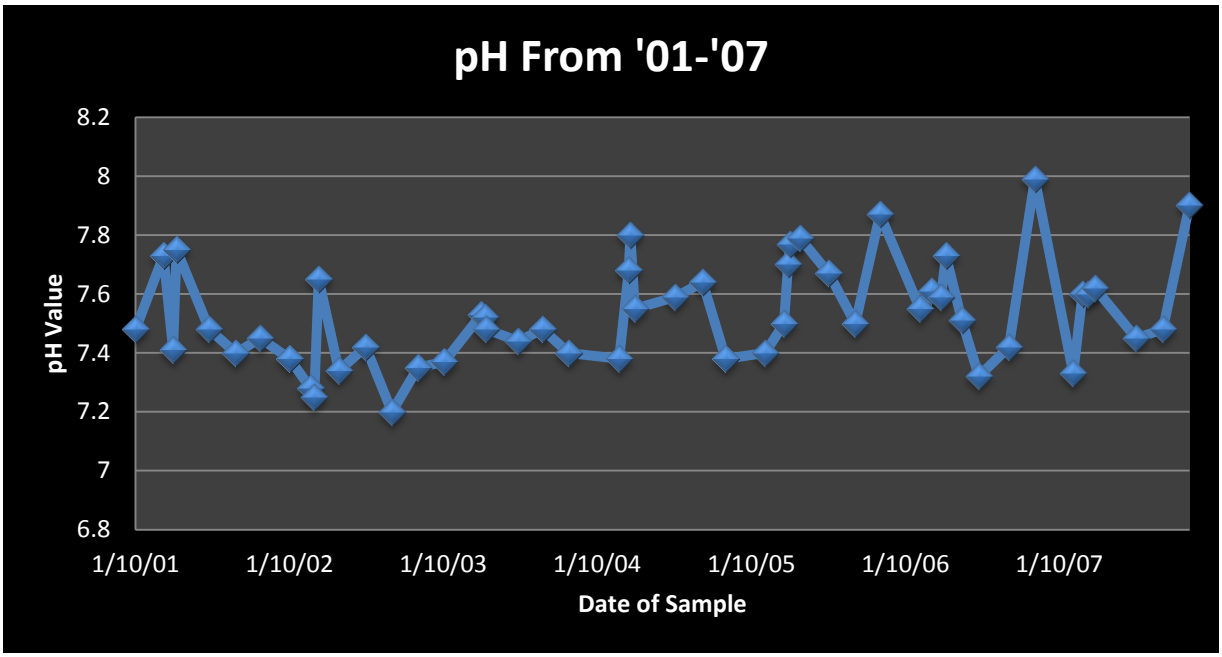
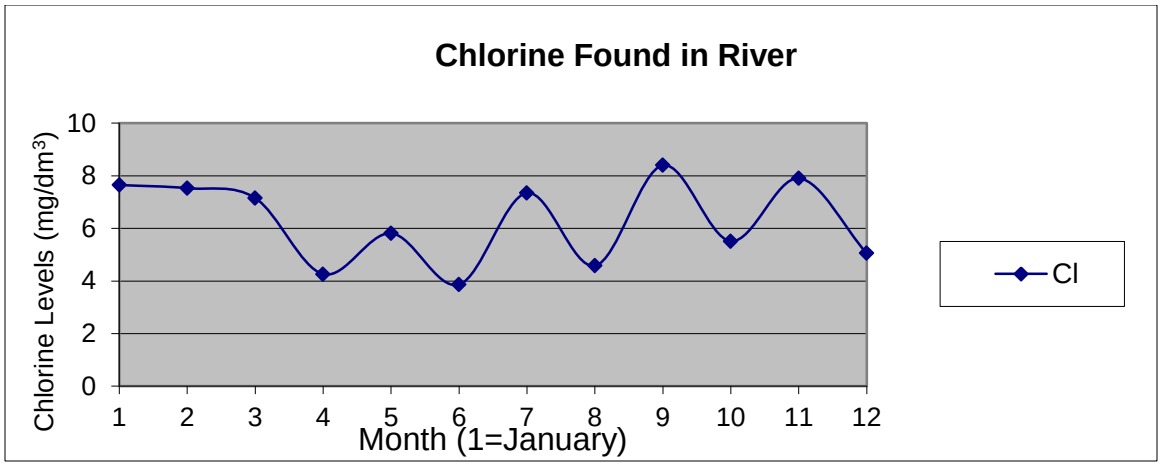
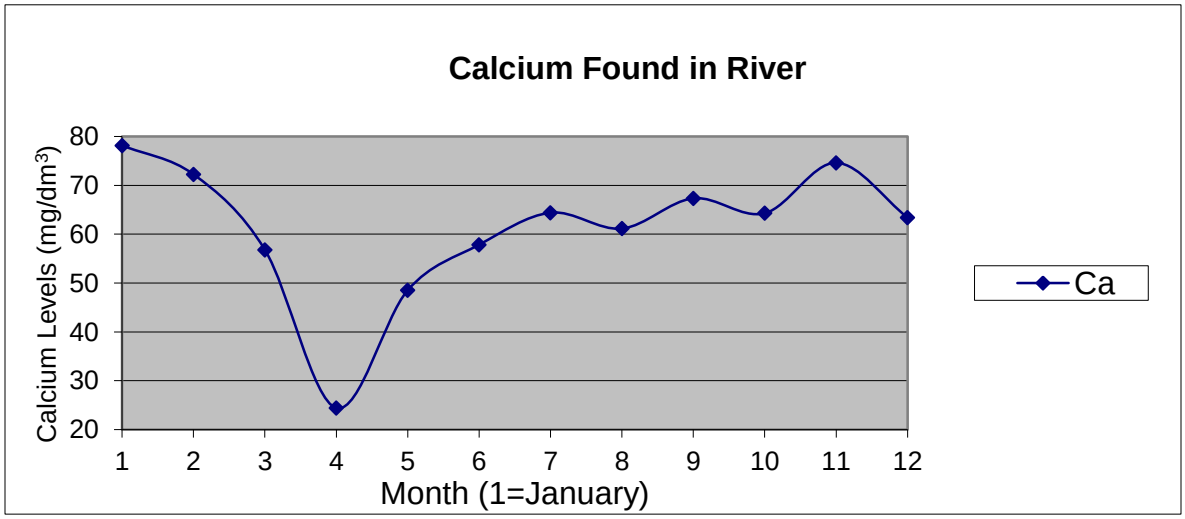
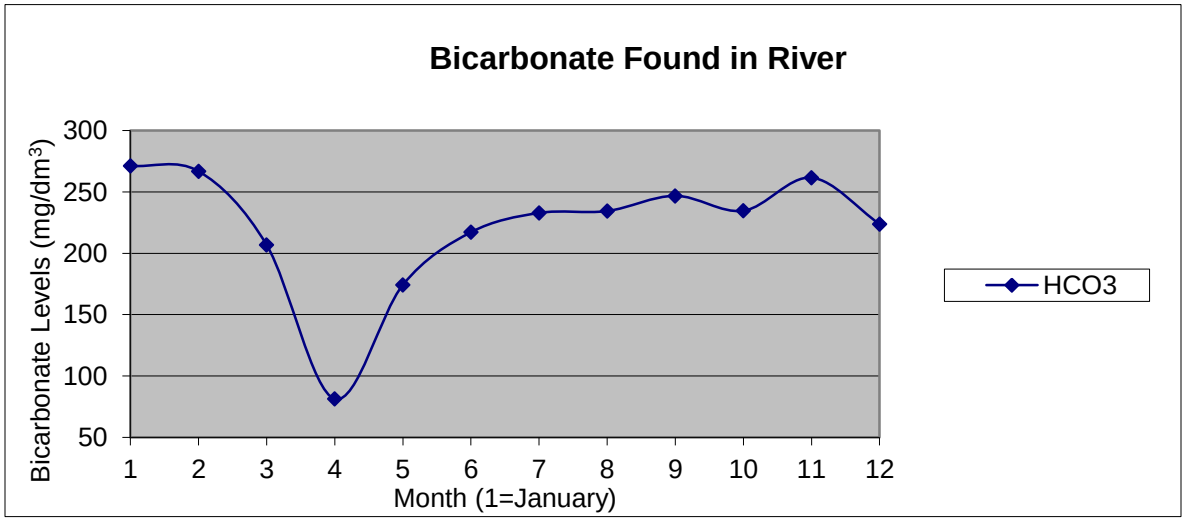


Chart 2: A line graph displaying the erratic quality of the pH levels in the Ugra River from 2001 to 2007 (Ugra National Park, 2013).

While these charts do show a basic tendency towards increasing the acceptable pH limits, there are some significant differences between them. In terms of the highest datum point, the '38-'69 data show a maximum of 8.8 while the '01-'07 data show a much lower value of 7.99. With such an extreme change in the maximum points, one would expect a large difference in the two sets of data in terms of their averages; however, this is not the case as the earlier and later data both have an average pH level of 7.5. In terms of most of the other data, it is most important to look at it on a month-by-month case. This can show trends in the levels according to what is happening in the environment. The data was averaged and collected by month and shown in the following (Semenova, 2007).


Chlorine Found in River
Chlorine Levels (mg/dm3)
10
8
6
4
2
0
1 2 3 4 5 6 7 8 9 10 11 12
Month (1=January)
Cl


Calcium Found in River
Calcium Levels (mg/dm3)
80
70
60
50
40
30
20
1 2 3 4 5 6 7 8 9 10 11 12
Month (1=January)
Ca


Bicarbonate Found in River
Bicarbonate Levels (mg/dm3)
300
250
200
150
100
50
1 2 3 4 5 6 7 8 9 10 11 12
Month (1=January)
HCO3

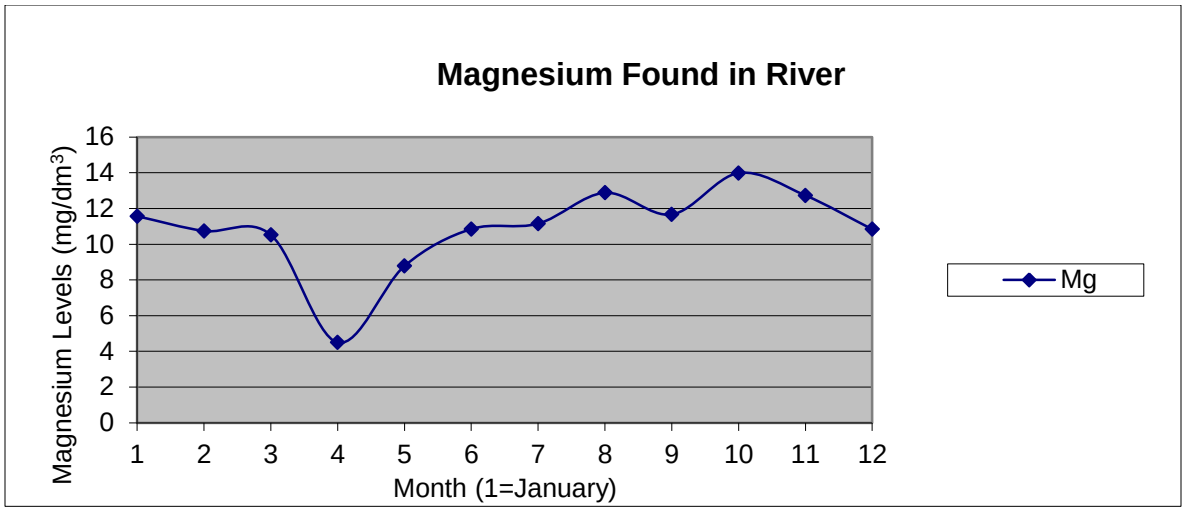


Chart 3-6: These graphs display the average data per month of chlorine, calcium, bicarbonate and magnesium respectively (Ugra National Park, 2013).

Most of the above graphs, while differing in terms of the elements they describe, show a downward trend in the month of April. This could very well be caused by an influx of melted ice from diluting the solutes. When the ice melts in the spring fresh water runs down into the rivers. If there is no comparable rise in the solutes to go along with the rising water, their relative amounts will decrease. In terms of the units calculated, (mg/dm^3), the $decimeter^3$ volume of water would increase but the milligrams of chemicals would stay the same. With the bigger denominator, the total value of the solutes/water would decrease as shown in the graphs above. Even though this data shows the elements in the water, it does not specifically give us an idea of where the contamination is coming from. Since the samples were only collected at one point on the river, there is no comparison data. If the data showed information from a location before the contaminated tributary and then again after, it would be easy to see if there truly was contamination. Any significant changes could be attributed to the water flowing in from the tributary and contamination could be retraced to a specific source. At present, the park rangers

have a few ideas of where the initial contamination could be coming from until further data from our tests can be collected.

2.6 Previous Steps Taken to Deal With Water Pollution

To help clean the water and prevent further contamination, it is important to look at examples of cases that have completed this venture. These examples could help by giving the rangers ideas that they could implement into their own park. In 1995, the windy city of Chicago, Illinois decided to try to correct the waste management protocols, or lack thereof, within the heart of the city limits. With the help of the Environmental Protection Agency (EPA), the officials of Chicago got to work on "implementing a multi-faceted prevention program, which incorporated strict laws, enforcement, cleanup and public education." (Ruesch & Brunner, 2001). These are key points to cleaning and keeping clean any body of water whether it is the Chicago River and its many branches or the Ugra River and its tributaries. The first implementation of this plan was to teach officers of the city the signs indicating that illegal dumping was happening in the first place. The program taught officers "the basic ability to recognize illegal dumping crimes, how to react safely when conducting investigations [and] how to involve the appropriate authorities" (Ruesch & Brunner, 2001). This allowed for the initial knowledge that the dumping was happening and where. To deal with the people who were dumping, the city enforced the offenses related to the crime and even increased the severity of them. Fines and jail time were the primary punishments for the perpetrators. Through these practices, Chicago was able to decrease the amount of money they had to use in cleaning their rivers because the amount of contamination was much lower. This process can only work if the people who contaminate are known. Since this is not yet the case in Ugra, more data was needed to identify the

contaminator. This extra data was supplied through the results of the water tests samples the team collected and analyzed (Ruesch & Brunner, 2001).

Chapter Three – Methodology

3.1 Introduction

The park rangers at Ugra National Park requested help in finding a solution to their alleged illegal dumping problem and recommendations to improve the tourism of the park. The goal of this project was to work collaboratively with the park rangers to collect water samples along the river and to investigate what needed improvement on the park to attract tourists. Our team determined that the interviews and water tests in the field were the best ways to determine the source of the pollution and to obtain the information needed in order to make recommendations on what the park could improve upon. This chapter will explain our methods to gather the required information.

3.2 On Campus Interview

Our group has conferred with Professor Jeanine Plummer, director of the environmental engineering program at WPI. Discussing the situation at Ugra National Park, the professor commented on the use of sensors and indicator strips to test the water's acidity levels and chlorine intake. As a habitat for living wildlife, the water of the river cannot be too acidic or too basic and should consistently have an approximate pH of 7.0 with minimal fluctuation. This is the optimal environment for most aquatic life in the river. Professor Plummer indicated that test strips that record the pH just using a simple color changing contact paper could be easily purchased. She mentioned that the strips could be purchased from chemical product stores or even a fish supply store, as this information is vital in creating a sustainable environment for fish.

Chlorine is of particular concern because of the paper factories around the area. Professor Plummer commented that chlorine is usually used in the bleaching process of the paper and, if not processed correctly, could cause terrible damage to the marine environment. There are very basic types of contact paper tests for chlorine that the professor mentioned, but more accurate tests call for sturdier devices. She guided us to look closer at different types of sensors that could improve our data. Sensors would be able to give us more data to look over and draw conclusions from (Plummer, 2013).

3.3 Analyzing Previously Recorded Data

Reviewing the data collected by Ugra National Park before leaving for Russia, we can begin to determine a basic understanding of the river. The data shows the elements and compounds found in the water and their levels. The trend of the information shows the general changes in the water.

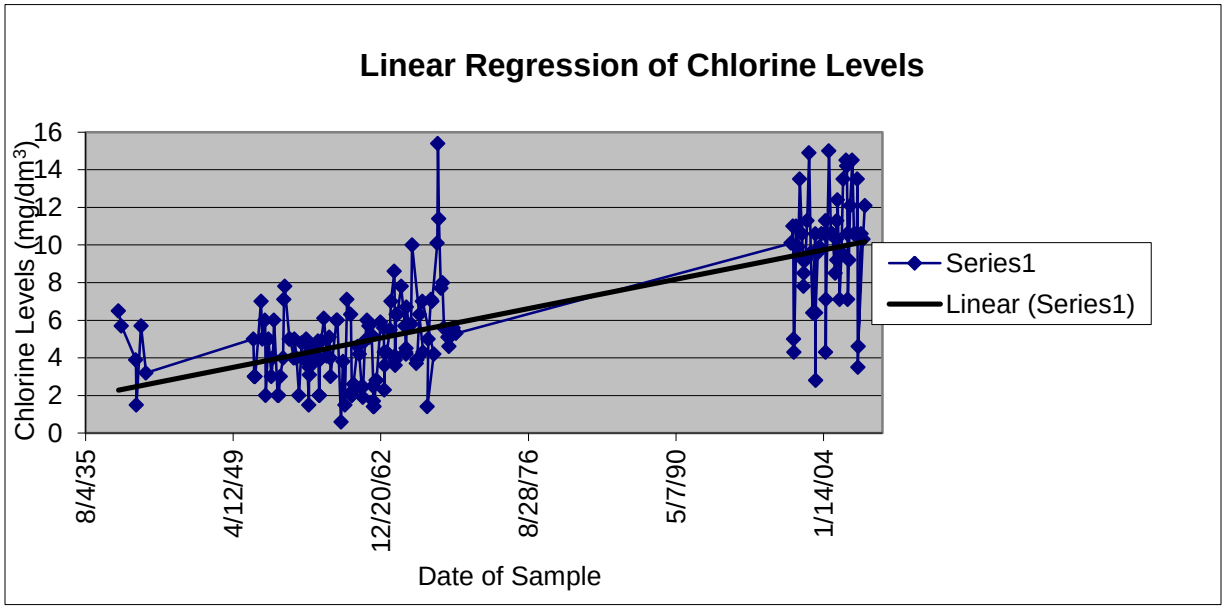


Chart 7: This graph displays the linear upward trend of Chlorine levels on top of the original datum points (Ugra National Park, 2013).

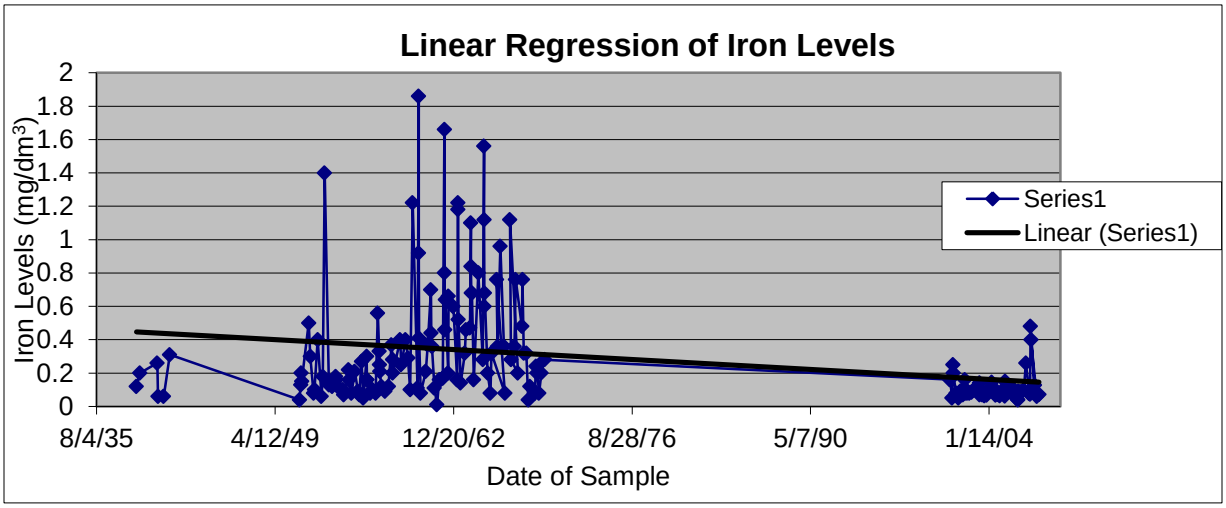


Chart 8: This graph displays the linear downward trend of Iron levels on top of the original datum points (Ugra National Park, 2013).

In the above graphs, it is evident that throughout the years there have been changes in levels of specific elements. While this data is important, more data is needed to understand the contamination.

Each of the datum points in the given charts is taken at the same position along the Ugra River. This does not allow for comparison among different areas along the river. Since the pollution is thought to be brought in through a tributary of the river, it would be best to test before and after this tributary intersects with the main river. If done along most of the tributaries in the park, this information can show us from which specific area the pollution is coming from and help narrow down the list of possible culprits. This testing is possible a couple different test kits.

3.4 Test Kit Information

Identifying the types of contamination within the water samples is paramount in understanding the underlying causes. In our interview with Travis Pritchard of the WaterKeepers, he referred us to three specific tests that are available for the types of waste we are trying to look for. The first type, *E. coli*, can be found using a Coliscan Easygel. This method is, "a simple, accurate and quantitative way to identify and differentiate coliforms and *E. coli* (true fecal coliform) from other bacteria in water" (Labs, 2013). To study the values of chlorine there is a test called the Chlorine (Free & Total) Color Disc Test Kit, Model CN-66 from the Hatch Company (HACH, 2013a). This is a testing mechanism that shows the reaction of DPD reagent and chlorine on a colored disc. This gradient wheel can show the amount of chlorine in the sample (Pritchard, 2013).

Figure 4: This color wheel will indicate the amount of chlorine in a given sample (HACH, 2013b).

From the same company, the Tannin/Lignin Test Kit can show the organic matter within the sample. Lignin, "is found in paper pulp manufacturing waste" and this test it can correctly

identify if the paper factories are a contributing factor of the contamination (HACH, 2013c). These tests can help us figure out what is in the river.

3.5 Data Collection

On site, water samples were taken up and down the river. We brought the aforementioned Chlorine and Tannin/Lignin tests kits from HACH to determine if the paper plants were having an adverse effect upon the Ugra River. Each day we went to a new location for a new sample location. In total, nine water samples were taken and tested. Both of the tests could have easily been conducted directly in the field however; the Tannin/Lignin test takes 25 minutes to complete so the team decided to conduct all tests at a later point.

The two tests performed were very simple and easy to perform. Sterilized beakers (including a cover) and distilled water for cleaning test tubes were provided by Ugra National Park. At each location, a beaker was filled with water from the location. The beaker was marked with a number that corresponded with the location. A map was then marked with the location that the water sample was taken from. At the same time, Tatiana Gordeyeva, Deputy Director of Science, one of the sponsors for the project, collected her own sample of the water in order to send to a lab for other tests that required specific lab equipment. The Chlorine test required ten mL of water: five mL were put in a "control" test tube and five mL were put in "water sample" test tube. A packet of chlorine reagent was added to the water sample test tube, mixed, and left to sit for three minutes to allow the reagent fully react with the water sample. After the three minutes, there is a three-minute window to get a reading for how much chlorine is in the water. To determine the concentration of chlorine residing in the water, the two test tubes are placed within a viewing device and, using a color wheel supplied in the kit, one can

determine the concentration of chlorine within the water. The Tannin/Lignin kit works in much the same way as the chlorine kit using a color wheel to determine concentration of Lignin in the water, however; there are slight differences in the preparation of the sample. The Tannin/Lignin test required .5 mL of the sample water, 4.5 mL of demineralized water, one drop of the lignin reagent, and one mL of sodium chloride. This solution was then mixed and left to fully react for 25 minutes. Instead of using the sample water as the control, like chlorine test, the tannin/lignin test used distilled water as the control to compare against the sample water being tested.

The original plan of the project was to collect the water samples using the catamaran owned by the park. The idea was to decorate the catamaran with the Russian flag and a WPI flag as a publicity stunt to raise awareness for the park's environmental causes. The weather did not permit our team to go ahead with this however. Instead, we spent one day on the catamaran and used a car to get to the rest of the water sampling locations. With the use of the car, we were able to make it to other parts of the park and learn about history and culture of the Ugra Park.

3.6 Interviews with Paper Plant Employees

To gain the perspective of the paper plants, our team set out to interview those companies that were suspected of polluting the tributaries leading into the Ugra River. The first paper plant that we visited is known as "ПОЛОТНЯНО ЗАВОДСКАЯ БУМАЖНАЯ ФАБРИКА" (Polotnyano Factory Paper Mill). Blinova Ludmilla Aleksandravna, the chief technologist at Polotnvano, was very forthcoming with the measures that the paper factory takes in order to keep the Ugra River clean. Recycling is very important to the Polotnvano factory. One of the main products made by the factory is cardboard and by using primarily recycled cardboard to make

new cardboard, the company cuts costs and helps the environment. Below is an image of the recycled cardboard that the company acquires:

Figure 5: Cardboard to be recycled by the factory (Photo taken by Matthew Crivello).

No harsh chemicals are used in the paper making process at the plant in order to keep the costs down and to be more environmentally friendly. Going along with the same principles, the factory is very conscience of the importance of the Ugra River and the many ecosystems that are dependent upon its cleanliness so the factory runs extensive tests of the water upstream and downstream from the factory in order to be certain that the factory is not harming the environment in any way. It is important to mention that this company has the luxury of being more environmentally conscious because they are financially secure and that is not true for other companies (Blinova, 2013).

Another paper factory suspected of polluting tributaries leading into the Ugra River was the "Tzoitsk Paper Factory". Likhachova Tatiena Yuzievna is an Environmental Engineer at Tzoitsk and she gave our group very honest answers about what was happening at the park both

financially and in regards to the tributary leading into the Ugra River. The Tzoitsk Paper Factory specializes in making parchment paper and during the Soviet era, the company noticed that the building in which the company was using sulfuric acid in their paper making process was ageing at an accelerated rate. At the time, the company did not have the regulations put in place to properly handle the harsh acid. The evidence now suggests that the acid was seeping into the structure of the building causing it erode and fall apart. Along with the structure of the building, the acid was also seeping into the ground and thus, into the tributary leading to the Ugra River. Since then, the company has built a new building in which the sulfuric acid is properly handled and the company takes precautions so that the acid does not seep into the structure of the building or the ground. According to Ms. Likhachova, the company does use harsh chemicals in its paper making process and pays the Russian government fees in order to dump some of those used chemicals into the tributary outside the factory. This is a purely economic decision. The company has determined that it is cheaper for the company to pay these fees rather than install an expensive water treatment facility. According to Ms. Likhachova, the parent company of the paper factory is going bankrupt and the paper factory is not very important to the company so it seems as though the factory will be closed in a few years. Despite the money troubles facing the company and the legal waste dumping, Ms. Likhachova assured our group that the factory is not to blame for the pollution of the tributary leading into the Ugra River. It is the belief of Ms. Likhachova that the villages and small farms upstream from the factory are to blame for polluting the water (Likhachova, 2013).

3.7 Interviews with Lab Technician and Environmental Lawyer

Determining the source of pollution in the Ugra River is one of the goals of this project. With that in mind, the team set out to gain an unbiased, scientific account of the state of the Ugra River. Irina Semenova, the leading scientific specialist for the research and production association "Typhoon", met with us to talk about the Ugra River and her account of the status of the river. She works for a laboratory that does many tests on the river water throughout the year and gives much of the information found to the park staff. The laboratory has about 2000 different locations from which they take water sample from and samples are taken from these sites about six times a year. There are between ten to twenty different substances that laboratory tests for including calcium, magnesium, nitrogen, sulfates, phosphorous, silicon, mercury, iron, cobalt, nickel, oxygen levels, and carbon-dioxide levels just to name a few. When asked about microbiology tests, Ms. Semenova told us that the laboratory that she works for does not do many on these tests but is equipped to do so. Microbiological tests are most commonly used to determine whether or not water is safe for swimming or drinking and Ms. Semenova stated that the city uses a different laboratory to test for such characteristics. In regards to her opinion about the quality of the water in the Ugra River, Ms. Semenova proudly stated "Ugra is one of the clearest in the region" (Semenova, 2013).

Gaining a legal perspective on the paper plant dumping was a crucial aspect to our project. If the paper plants proved to be at fault for illegal dumping practices, then it was very important to know how the park should move forward legally. To get this legal advice, our team interviewed Yuri Kazannikov, an environmental lawyer that works with the park to help protect it legally. Mr. Kazannikov is very passionate about the park and even works for park in his free

time for no charge. Through Mr. Kazannikov, we learned the process that a park must go through in order to deal with an environmental violation. According to Mr. Kazannikov, the courts and policemen are biased towards the park making it very difficult to make people and companies pay in the courts for violations. Through very strong scientific evidence of violations, the park has been able to punish violators in the past. So it is apparent that making a company or an individual pay for violations is possible, but Mr. Kazannikov also stated that because this is a national park, the administration does not want the violators to simply pay fines for the violations; the park wants the violators to cease all actions which harm the park environment. This is much tougher to enforce and much more difficult to achieve in a courtroom than getting a violator to pay a fine. When asked about the existence of government incentives for a company to "go green", Mr. Kazannikov simply said that no such thing exists in Russia. Due to the failure of the Soviet Union, the people of Russia do not want the companies receiving government money unless it is in exchange for a product such as for the military. It is Mr. Kazannikov's belief that Russia should change their ways to follow the example set by the U.S. and put in place incentives for companies to be more environmentally friendly (Kazannikov, 2013).

3.8 Interview with Ugra Park Director

To get the official opinion of the condition of Ugra our team interviewed the director, Victor Grishenkov. Through Victor, our team gleaned information on the history and the establishment of the park. The park was established about 30 years ago in 1997. According to Victor, regulations made it very difficult to establish a national park but the help of scientists and government officials made it possible. The locals were not happy about the creation of the national park because of the restrictions the park imposed on hunting and the expansion of villages in the park territory. Despite the locals' displeasure in the initial establishment of the

park, it is because of the park that the Russian Desman is back to healthy numbers. The Russian Desman is mammal without many special characteristics except for its existence since the prehistoric times. This rare trait makes this animal very important to many scientists studying animals of the prehistoric era. Finally, it is through the interview with Victor that the team learned about the park's need to increase tourism. The park would like to be on par with national parks of the United States. Currently, the park needs to increase the tourism of the park and to do that Victor is looking to our IQP team for recommendations.

3.9 Measures to Raise Public Awareness

In an effort to raise public awareness of the park, during our time in Kaluga, there was a television special about the Ugra National Park. The television crew found out that we were working on the river to collect water samples and decided to conduct an interview of our team. Through the use of television we were able to reach many more people than we ever would have with print advertisement.

Figure 6: A frame from the television interview on Russia 1 showing the Tannin/Lignin Test Kit (Russia 1).

3.10 Summary

In sum, we conducted formal interviews with the experts at WPI and in Chicago. We conducted formal interviews with the paper plant owners, a lab technician, an environmental lawyer, and with the Ugra National Park director. These various people had experience and knowledge about water pollution, the legal system, and the inner workings of a beautiful park. Along with interviews, we also went to the field directly to collect water samples for testing. Collecting water samples ourselves insured the validity and impartiality of the water tests. These methods allowed us to make recommendations for the increase of tourism and to provide unbiased test results on the pollution of the river.

Chapter Four – Results and Analysis

4.1 Introduction

During the excursion to Ugra National Park, data was collected through interviews, exploration of the park grounds and immersion into the life of the area. Throughout this endeavor the quality of the Ugra River was tested and the overall state of the park was noted.

4.2 Water Testing Results

4.2.1 From Data Collection

After two weeks of investigation of the park's waterways, nine samples were taken and three key people met with us for interviews. The water samples were tested using the aforementioned test kits for Chlorine and Tannin/Lignin and every test came back negative or negligible for both possible contaminants. This data corroborates the discussions and information we collected from the workers from the paper companies. The representative from the Polotnyano Factory Paper Mill informed us that little to no chemicals are used in the production of their cardboard and they even monitor the water quality themselves to make sure they are not polluting (Blinova, 2013). The other factory did admit to dumping within the river but they are within their legal rights to do so and, according to our tests, it is not doing much damage (Likhachova, 2013). Factoring in the likelihood of the latter factory's approaching close, this waste is negligible.

Since the paper factories do not seem to be polluting the water, there is more than likely a different impurity. While there was worry that sewage or animal waste might be getting into the

streams, the tests that would definitively prove one way or another were not able to be completed. Sadly, microbial testing for *E. coli* was not available through the park's laboratory that we were using.

4.2.2 From Touring the Park

Despite the ranger's belief in contamination, one would never think the river is anything less than immaculate when visiting Ugra National Park. Its waters seem beautiful and clear as seen in the picture below:

Figure 7: A picture showing the bottom of the river through the clear waters (Picture by Madeleine Gomel).

The water is unblemished, its transparency unparalleled. Floating upon the river, all that was seen was clean water and green scenery as far as the eye could see. This, however, is not true of the tributaries leading into the river.

Whilst on the property of the national park, it is near impossible to see any damage to the park, off the premises there are waterways that do seem contaminated. Most of the tributaries do seem to match the high quality of the large river, but there were a few of them that were worrisome. On one of the stops, there was an intense, putrid smell and the water seemed as dark as the Mississippi River back in the United States.

Figure 8: A much different scene than the park, this picture depicts one of the tributaries under a bypass with dark, murky water (Picture by Madeleine Gomel).

This section of the tributary does seem to display traits of contamination, but the type of toxin is unclear and would call for further testing. At a site further down the river there was trash thrown all around the mouth of the tributary. While this one did not have a blatant smell like the other the waters did show a type of cloudiness within them.

Figure 9: These red arrows point to the trash on the bank of the tributary. These include: bottles, fabric and paper (Picture and editing by Madeleine Gomel).

These tributaries are definitely not as clean as they should be, however, they do not seem to be influencing the quality of the Ugra River greatly and are not the biggest issues facing the national park at this time.

4.3 Analysis of the Park Area

Getting to the park is a difficult feat without exact knowledge beforehand of where to go. The visitor's center is a good distance away from the entrance of the park and is hidden off a deserted road alongside a row of other buildings. Inside, it has great information about the animals, history and trails of the park but remains unseen due to its location. Tatiana Gordeyeva

told us in regards to finding the park that people who really want to come already know how to get here (Gordeyeva, 2013). While this may be true, it hinders a huge population from being able to attend the park. People who have never been to the park before may be apprehensive about venturing into the wild without directions. Although the exterior boundaries of the park are marked with small signs on the highway there is very little when getting into the depths of the park.

Beautiful and informative trails are scattered throughout the national park, but where they are exactly is hard to know. There are maps on the website detailing their location, but knowledge of the area is needed in understanding them. Once on the property of the park, there are few signs pointing the way towards trails, vistas or historical points. The only markers are the trailhead signs.

Figure 10: A picture of the sign at one of the trailhead in Ugra National Park (Picture by Svetlana Nikitina).

Signs like this are very helpful but cannot be the only representation of the trail in the park. For most of the touring of the park, it was unclear where we were. Places that seemed to be of no consequence suddenly turned into a trail. The guides knew exactly where they were but, to the

untrained eye, it was all dense forest. Coming from either the highway or the river, there were never any indications to where the trails started.

Along with the lack of posted signs about trailheads, there was also a dearth when it came to explaining the historically significant areas of the park. War memorials and old battlegrounds speckle the park all over but are insufficiently identified to the passersby. Old trenches and fortifications could be not ten feet away and yet lay unseen. These relics of the past should be seen and revered but, just as the trailheads and visitor center, they remain hidden in the wilderness.

s. 

Figure 11: Restored World War II trenches hide in the brush unless specifically looked for (Picture by Matthew Crivello).

Once found, the trails also leave something to be desired. As they sweep through scenic views of forests and rivers, the paths can get treacherous. Slick mud coats the ground while broken banisters that at one time were present give a false sense of safety. Many of the pathways seem

to be made from cars driving over the grassy terrain repeatedly. This leaves the ground with two trails divided by a small section of nature between them. While not too inconvenient for humans, this could be dangerous for small animals that may stay within this segregated section. Numerous frogs were spotted in this division as well as insects and small mammals that called this middle ground their home. This needs to be remedied as humans walking on this terrain could be deadly for these small creatures.

Another observation of the tourist areas revealed a startling lack of sufficient trash receptacles in most areas. In Russia, it is very usual for families to go picnicking when the weather is nice. Areas around the park are equipped for picnicking with tables and chairs however they have no trashcans. Without designated disposal sites tourists resorted to littering the area with their trash.

Figure 12: Picnic tables and campfire area for tourists. Not pictured, large waste pile of trash off to the right near the riverbank (Picture by Matthew Crivello).

In other picnic areas, there were small trashcans but they were not adequate for the national park. There were no tops to them and they were not reinforced, as they should be considering there are

bears and other large mammals in the area. Trash receptacles should be animal proof for their protection; animals can get severely hurt by getting stuck in trash or eating something harmful.

4.4 Summary

Overall, the waters of the park seem very clean even though the tributaries leading into them might have some slight problems with trash and unexplained contamination. The land of the park holds great importance but is poorly represented to the outside world. On the park, there is also a lack of sufficient indication to where trails are located and are somewhat dangerous once on them. The park needs to become more tourist-friendly if it hopes to increase its attendance.

Chapter Five – Conclusions and Recommendations

5.1 The State of the Ugra River

Reviewing the water test analysis, it quickly becomes clear that there is not enough proof to definitively say that the paper factories are contaminating the Ugra River or its tributaries. With both the Lignin and Chlorine tests showing negligible amounts, there is no evidence pointing towards the factories. This is not to say, however, that the water is perfectly clean.

Our tests were very limited in scope; they could only assess for the two levels in question. While these are important results when checking for paper pollution, they are not useful for any other possible contaminant. Different comprehensive tests should be performed in order to completely rule out contamination. Now that we understand the area we recommend that tests for agricultural waste and city waste be conducted as soon as possible.

These possibilities are fairly easy to test as both of them would contain fecal waste and, as discussed earlier in the paper, would contain *E. coli*. While the test facility the national park uses is not capable of providing these analyses, simple home tests should not be hard to find. Back in The United States, The Home Depot, Inc. sells kits for in-home testing for less than ten dollars.

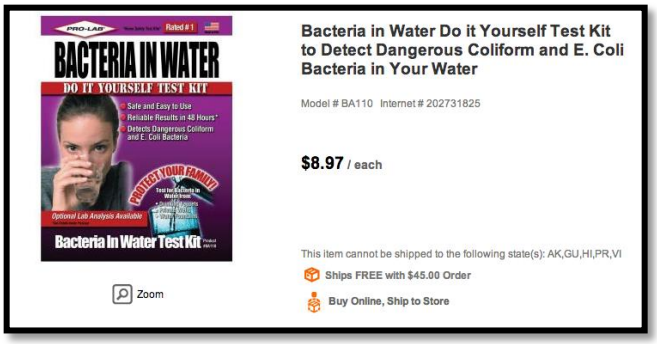


Figure 13: This is a picture of The Home Depot, Inc. test kit for sale on their website (The Home Depot, 2013).

Since the Ugra River gives water to the animals of the national park and is home to a lot of aquatic life it is very important that it remain untouched by chemicals and pollutants. While it seems that the paper factories are not contributing to any contamination, there still could be other factors that should be looked into. For now, the Ugra River seems to be a beautiful and pristine place whose natural radiance is not disturbed by pollution.

5.2 Improving Ugra National Park

The national park is scenic wonderland, however, most of the Russian public does not take advantage of this nearby neighbor. With a shortage of visitors, the park is failing in its goal of bringing eco-tourism and recreation to the people of Russia. In order to increase visitation the park needs to renovate and become a more tourist-friendly area. By repairing the old structures and adding new ones, the park should be able to attract a larger visitor base. The most important change, however, would be converting the Russian public's opinion of the park.

5.2.1 Short-Term Goals

In the near future the park needs to improve its visibility to the public, mark its trails so they are easier to find and add accessories to its campfire sites. The park is not far away from the city of Kaluga, but with the lack of advertisement one would barely know it existed at all let

alone less than an hour away. Small signs on the side of the road state that you have entered the park's territory but give no further information. From the road, there is little to no indication of how to actually enter the park and enjoy its trails and history. The visitor center could help people find their way, but this too is hidden by a lack of signage. To fix this we propose adding more signs that lead up to the park, signify the trail entrances and indicate the historically important areas to the tourists.

Ugra National Park should mimic the sign style that its United States counterparts use. In places like Yellow Stone, Grand Canyon and Big Bend National Parks there are never any doubts of where the entrance or visitor centers are located.

Figures 14-16: The Big Bend (top left) and Grand Canyon National Park (top right) entrances as well as the Yellow Stone Visitor Education Center (bottom) are clearly marked with large, eye-catching signs (National Park Foundation, 2013), (National Park Foundation, 2013; Rince-Art, 2013), (ADAM, 2013).

These signs bring attention to the United States parks and since Ugra sorely lack attention, we recommend that they copy this flashy mode of advertising. However, once the park does in fact lead people to it there is still the matter of showing them where exactly to go.

The trails of the park need to be marked at the trailheads and continuously throughout the trail. Signs at the trailheads are necessary for anyone touring without a guide to find the path. These signs can also list sites on the trail; historical markers, campgrounds, campfires, picnic tables and especially beautiful scenic overlooks can all be specified as well as the overall length of the trail.

Figures 17-23: On the far left is an example of a trail marker at multiple trailheads depicting the length of each. The signs to the right each depict a different activity that can be shown on a trail sign. They are fishing, picnicking, viewing scenic overlooks, viewing historical markers, kayaking and camping (in clockwise order starting from the top left) (Periodic Wanderings, 2013), (Campgroundsigns.com, 2013a), (Campgroundsigns.com, 2013c), (ComplianceSigns.com, 2013), (Centerline Supply, 2013a), (Campgroundsigns.com, 2013b), (Centerline Supply, 2013b).

These additions will greatly improve the overall ease of access to the trails. To further enhance the park, paths need to be marked every so often throughout it as well. In dense forest, it is easy to get lost or wander off the path; these markers can mean the difference between a lost tourist and a happy one. Trails can be marked in many different ways some of which are very easy to set in place. The simplest of these styles is a paint stripe on trees every few meters down

the path. Another option is to have a sign stuck into the ground with the name of the trail as a marker. This option is more expensive and can take away from the natural romanticism of the path.

Figure 24: Option 1) The painted trail maker (Virginia Trails, 2013).

Figure 25: Option 2) The metal sign trail marker (John Muir Trail, 2013).

The last type of sign that needs to be added to the park is that which mark the history of the surrounding area. Ugra National Park is fortunate to have such rich history on its estate, but without a guide most of the information on them is lost to the average passerby. As a place of battle during the Tartar yoke and as an important front during World War II, the area has numerous battlegrounds, trenches and burial sites but few of them are labeled. If they are labeled, the signs still do not give all the information that they should.

Giving detailed accounts of the important past of the area is essential for the park. This could bring in many different types of tourists to the park. History enthusiasts could come to see the holes where bombs were dropped; teachers with their classes in tow could view the trenches left behind by the wars long since passed. An example of a historic marker can be seen below.

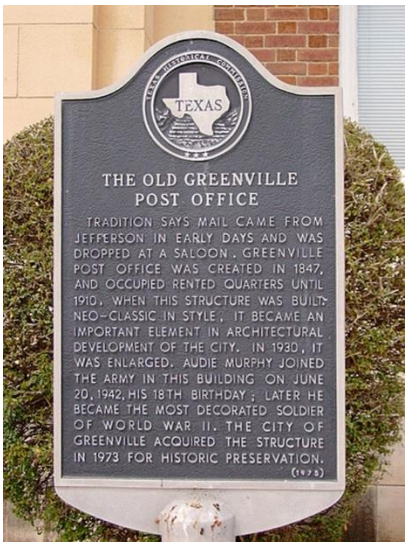


Figure 26: A north Texas historical marker in front of the city's post office (Stout, 2013).

This marker details the importance of the Greenville, TX post office during World War II. Without it, no one would think that a random post office in north Texas had any significance in the war, but this marker proves otherwise. With signs like these scattered throughout the park, the historical element of the park could be prominently displayed and bring in more visitors.

To further increase tourism, the park needs to become more tourist-friendly. This means creating areas of interest for the visitors. Knowing that Russians enjoy picnics, the park should focus on bettering the areas dedicated to this and also create more of them. The areas that currently have picnic tables and campfires are not up to par with the international level that Ugra is striving towards. Some easy overhauls could greatly change the image of these sites and make them a place tourists want to visit. The picnic areas need to be redone in new wood and maybe coated with a varnish to protect it from the harsh weather. This upgrade needs to also happen for

the stairs and banisters in the park. The degrading wood cannot hold up the weight of a person and falls underhand. Safety of visitors needs to be the highest priority of the park so this must change. New banisters and stairs should either be made of wood with a varnish or metal to ensure no deterioration.

To further improve upon the area, trashcans should be placed around the picnic areas for visitors to dispose their trash. These cannot be any trashcans; in national parks it is very important to have animal safe trashcans.

Figure 27: An animal safe trashcan made from metal with an animal proof lid (Securr, 2013).

Above is an example of one type of animal-safe trashcan. With a locked handle that paws cannot grasp, this trashcan makes sure nothing gets into the disposed of waste that should not. This method is safer for both humans and animals. Wildlife is attracted to the smell of the food left behind in trashcans and will dive right in and snag what they find. Inappropriate goods can lead to sickness in animals and the animals could also be caught in the trash. Things like six pack plastic rings and plastic bags can really harm animals if they are snared with them. Also, the animals that feast from the waste bins could stumble upon groups of humans and possibly hurt or

be hurt by them. Simply replacing insufficient trashcans and implementing more around picnic areas would make the land, the animals and the people much happier.

5.2.2 Long-Term Goals

To further improve on Ugra National Park, the overall experience for the visitors needs to be improved. This is a slightly more daunting task as it calls for more money and also more time. Further improving the trails calls for professional help that can be costly but greatly adds to the aesthetics and safety of the park. Also, by adding fun activities for visitors the park could entice a completely new group of tourists who want more physically tough feats. To improve the visitor base of the park any further, there needs to be a change in the mentality of the people. Using the upcoming recommendations, Ugra can and will change the views the public has and increase its tourism.

The park's many trails are clearly represented on maps found online and in the visitor center however, through field research within the park it is apparent that the trails need more distinguished markers on their actual grounds. While touring the trails it is hard to tell whether or not the path is a real trail or a road which makes it hard to stay on the route and easy for tourists to get lost. For example, there is a boulder left behind by the movement of glaciers many years ago in the park premises. The entrance to this trail is barely distinguishable from the surrounding forest and, without a guide present, would have been impossible to find. To solve this problem, the park should plan to blaze its trails professionally to make them more distinguishable.

Figure 28: An example of a trail in which was only accessible by car (Picture by Matthew Crivello)

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Figure 29: Boulder left behind by a glacier that passed through the Ugra River region centuries ago (Picture by Matthew Crivello).

Since the park already has the foundations of the trails laid out it would be very easy to mark them appropriately. Trails near more tourist-heavy areas such as the swamps are a good

model for what the rest of the park should be. These areas had wooden paths that were easy to follow and were also very well maintained.

Figure 30: Wooden paths in the swamps (Picture by Madeleine Gomel).

To improve the trails they need to be widened and the underbrush should be cleared. There are different options when it comes to the extent to which this underbrush is removed; the trails can be cut to either short grass or be cleared completely. For Ugra National Park it would be better to go with the latter option. Since insects, frogs, snakes, and small animals roam the grass it would be safer for both them and humans to make the distinction between forest and path as well defined as possible.

Gravel, sand, or crushed stone could be added to these cleared trails to further help this cause and to also significantly improve areas of the park that tend to get slippery when wet.

Figure 31: Example of a gravel path inside of a park (The City of Columbia, 2013).

This type of trail obviously marks the barriers of the trail without disrupting the harmony of the natural scene. Other benefits to using gravel are that it creates a stronger foundation for the path making it safer for walkers and also helps to fight off erosion. With these renovations the trails would vastly improve in terms of ease of use and tourists would feel more comfortable walking on them (Almond, 2013).

To further improve the visitor experience, it is recommended that kayak and canoe landings be added in multiple places down the river. The ability to canoe would bring a new demographic of visitors to the park who enjoy physical activity or who would like to really travel the river. There are two different types of landings, stationary and floating, but the better option for Ugra is the floating. We do not recommend the stationary landing because of the vast changes in the height of the river and because it would not do well in the frozen winters. A floating landing can change with the depth of the river, is easier to install and can easily be removed and stored when the river freezes.

There are many different options for floating docks ranging from build-it-yourself to premade designs. The kit we recommend comes from a company by the name of Dock Builders

Supply™ and costs $1,125.88 but does not include lumber. The full list of what comes in the kit can be found in Appendix K (Dock Builders Supply™, 2013).

Figure 32: Example of a floating dock that would be anchored to the riverbed by cables or rope (Dock Builders Supply™, 2013)

This dock is a simple floating platform that anchors to the riverbed to keep it in place. We recommend modifying this design slightly with anchoring posts to make the dock more stable which is one of the secondary options of the kit. It does require more work to install, but it makes the dock look more polished and professional. Also, the posts would make the dock safer as the dock would be unable to tip over. A full guide on how to build a floating dock can be found in Appendix L.

Figure 33: Example of a floating dock that is held in place by stationary posts (Dock Builders Supply™, 2013)

Lastly, but also most importantly, we recommend that the park start up community outreach programs. These should be directed to school age children in hopes of teaching them to appreciate the park and all the work it does. Changing the mindset of a people starts with the new generation; it should be shown to children that the park is important and also a great place to travel to in hopes that they will understand the significance of Ugra. We have selected four different programs that will help accomplish this goal: "A Trip Around the Park", "Family Badges", "Bringing the Park to School" and "Adopt an Animal".

In "A Trip Around the Park" school-age children are given fake passports in which they can fill out their personal information and even draw a self-portrait of themselves. They then take these passports as they hike around the park with either their class or family. At significant checkpoints in the park (these can be historic, scenic or educational) the children are given a token to represent that they have made it to this point. These tokens can be stamps, stickers, small candy, postcards and/or anything else that is kid-friendly and something that would make the children want to keep going. The goal of this exercise is to have the kids go all around the

park in order to collect as many tokens as possible. An optional addition to this is to have the last stop be a picnic area where the families can relax and enjoy their lunch.

Another program that rewards walking the park is the "Family Badges" program. Families earn badges for how far they have hiked. These badges become bigger and more elaborate the farther they walk incentivizing children to keep going. Once the families get to a certain high benchmark, they are immortalized on a plaque in the visitor center.

The past two options have required people to visit the park, however, it would behoove the park to also influence people where they live. The third and fourth options both are geared towards implementation in the schools so that the children have to participate and listen. In "Bringing the Park to School", rangers visit schools with rehabilitated animals to intrigue the children. These rangers prepare an informational lecture that is both fun and entertaining while also using the animals to interest the children.

The last outreach program is called "Adopt an Animal". Children can symbolically adopt an animal with their family or classroom. Symbolic adoption is a method that the World Wildlife Foundation uses to raise money for endangered species. In their program, they sell adoption packages for $50 on their website. These packages contain a small stuffed version of the real animal, a certificate of adoption, information about the species and a picture of the real animal. While this is much more extensive than what Ugra National Park should do, it paints a clear guide to follow. The park can send out pictures of animals along with information about them to different classrooms. The children can name their animal and write letters about how they would like to meet them and make sure that their habitat stays safe (World Wildlife Fund, 2013).

All four of these projects are supposed to create a link between the children and the park. With an emotional tie to Ugra, the kids will go to the park more often as well as continue the tradition when they themselves have children. While this will probably be a slow process and mostly an uphill battle, it will be completely worth it if it helps the park gain visibility to the public.

5.2.3 Summary

Through the implementation of these renovations, additions and programs the park will be on par with international parks. The changes of the trails will better the look of the park, make it easier for visitors to find as well as increase the overall safety for both humans and animals. Adding in fun activities such as picnicking and kayaking will engage the visitors and create an exciting atmosphere that they will love. The implementation of child-friendly programs will hopefully increase the visitor base of the park and, albeit slowly, change the perspective of the public on the park. Currently, Ugra National Park is a lovely place and many tourists have a great time there. Without any changes, the park is a fantastic place to go and anyone would be lucky to tour the area. Through the execution of these recommendations, we hope to improve upon the park to make it the best that it can be so that it will gain the respect it deserves.

References

ADAM. (2013). The Old Faithful Observation Point View – Hike For An Aerial View of Old Faithful.

Almond, H. (2013). How to Build Trails. Retrieved October 9, 2013, 2013, from http://www.trails.com/how_2436_build-trails.html

avgust. (2013). RF Products. from http://www.avgust.com/product/?country=rf

Blinova, A. (2013). [Chief Technologist at Polotnvano Factory Paper Mill].

Campgroundsigns.com. (2013a). Fishing Symbol Sign.

Campgroundsigns.com. (2013b). Kayak Symbol Sign.

Campgroundsigns.com. (2013c). Picnic Area Symbol Sign - RM-120, SKU: X-RM-120.

Center for Disease Control. (2013a). General Information - E. coli.

Center for Disease Control. (2013b). Vibrio cholerae.

Centerline Supply. (2013a). Centerline Supply Highway Products. from http://www.centerlinesupply.com/highway_products/pavement_marking_supplies/traffic/signs/guide_signs/destination_signs/destination_signs_d7_d10

Centerline Supply. (2013b). d9_3_camp_ground.jpg. from http://www.centerlinesupply.com/highway_products/pavement_marking_supplies/traffic/signs/guide_signs/destination_signs/destination_signs_d7_d10/144368d69d593e/1/d9_3_camp_ground.jpg

ComplianceSigns.com. (2013). Recreation: Scenic Overlook sign #PKE-17210 - Safety Signs Labels-ComplianceSigns.com. from http://www.compliancesigns.com/PKE-17210.shtml

Dock Builders Supply™. (2013). Dock Builders Supply. from http://www.dockbuilders.com/floating-dock-kits.htm

Gordeyeva, T. (2013). [Deputy Director of Science for Ugra National Park].

Grishenkov, V. (2013). [Park Director at the National Park Ugra].

HACH. (2013a). Chlorine (Free & Total) Color Disc Test Kit, Model CN-66. from http://www.hach.com/chlorine-free-total-color-disc-test-kit-model-cn-66/product?id=7640219519#

HACH. (2013b). DPD Chlorine Color Disc - Overview | Hach.

HACH. (2013c). Tannin/Lignin Test Kit. from http://www.hach.com/tannin-lignin-test-kit/product?id=7640218467

IUEC. (2013a). National Park Ugra. War Memorial Path "œPavlovsky Foothold at the Ugra River in 1942-43". from http://eng.iuec.ru/activities/social/ugra/

IUEC. (2013b). War Memorial "Sukovskiy Foothold at the Ugra River in 1942-43". from http://eng.iuec.ru/activities/social/ugra_sukovskii/

John Muir Trail. (2013). Complete Guide to John Muir Trail -Trail log. from http://johnmuirtrail.org/trail.html

Kazannikov, Y. (2013). [Environmental Lawyer].

Kondrosvskaya. (2013). Kondrovskaya Paper Company. Retrieved 5/2/2013, from http://www.kpc.ru/about.shtml

Labs, M. (2013). Coliscan Easygel. Retrieved May 2, 2013, from http://www.micrologylabs.com/page/93/Coliscan-Easygel

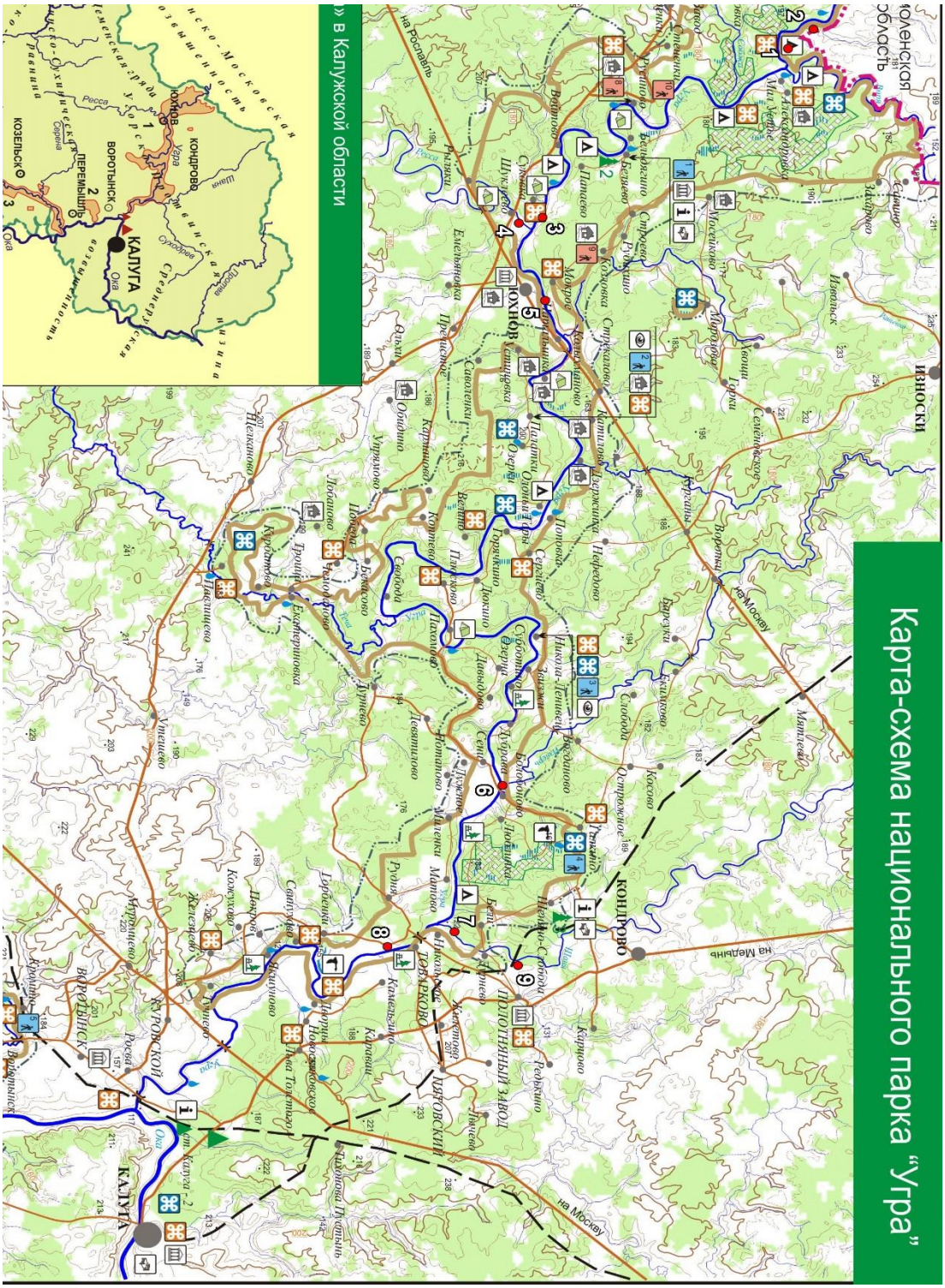
Likhachova, T. (2013). [Environmental Engineer at Tzoitsk Paper Factory].

LOG, W. (2013). Storm Datalogger.

Map Walk. (2013). Great Stand on the Ugra River. from http://mapwalk2013.clevelandhistory.org/great-stand-on-the-ugra-river/
MicrobeWiki. (2013). Escherichia coli. Retrieved May 2, 2013, from http://microbewiki.kenyon.edu/index.php/Escherichia_coli
National Park Foundation. (2013). Big Bend National Park.JPG. from http://cdn.nationalparks.org/sites/default/files/kcfinder/images/Big%20Bend%20National%20Park.JPG
National Park Service. (2013). Chihuahuan Desert Biosphere Reserve.
Periodic Wanderings. (2013). The Colima Warblers of Big Bend.
Plummer, J. (2013). [Director of Environmental Engineering at Worcester Polytechnic Institute].
Pritchard, T. (2013). [Water Quality Lab Manager at San Diego Coastkeeper®].
Rince-Art. (2013). Route 66 Journal - Day 7. from http://rince-art.blogspot.ru/2010/12/route-66-road-trip-day-7.html
Ruesch, P., & Brunner, J. (2001). Attacking Illegal Dumping with a Smart Idea. *Waste Age, 32*(5), 6.
Russia 1 (Writer). Yukhnovsky Area, *Kaluga*.
Securr. (2013). Animal-Proof Trash Containers. from http://securrtrashcans.com/animal-proof-trash-containers/
Semenova, I. (2007). Dataset of Ugra River Quality Analysis.
Semenova, I. (2013). [Leading Scientific Specialist for the Typhoon Research and Production Association].
Stout, B. (2013). Terrell Texas Daily Photo: Ima Hogg. from http://www.texasdailyphoto.com/2009/03/ima-hogg.html
The City of Columbia. (2013). Cosmo-Bethel Park Lake Trail, 4500 Bethel Street, Columbia, MO.
The Home Depot. (2013). Bacteria in Water Do it Yourself Test Kit to Detect Dangerous Coliform and E. Coli Bacteria in Your Water-BA110 at The Home Depot.
The IUCN Red List of Threatened Species. (2008). Desmana moschata (Russian Desman, RUSSIAN DESMAN). Retrieved September 19, 2013, from http://www.iucnredlist.org/details/6506/0
The IUCN Red List of Threatened Species. (2013). 1994 Categories & Criteria (version 2.3). from http://www.iucnredlist.org/static/categories_criteria_2_3
The Ministry of Natural Resources and Environment of the Russian Federation. (2013a). Maps and charts. National Park "Ugra". from http://parkugra.ru/turizm/karta_shema.php
The Ministry of Natural Resources and Environment of the Russian Federation. (2013b). Recreational Resources. from http://parkugra.ru/activity/rekreaz.php
UNESCO. (2012). World Network of Biosphere Reserves.
UNESCO. (2013a). MAB Biosphere Reserves Directory.
UNESCO. (2013b). MAB Programme. Retrieved May 2, 2013, from http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/man-and-biosphere-programme/
Virginia Trails. (2013). blue-blazed-trail.jpg. from http://virginiatrails.files.wordpress.com/2010/10/blue-blazed-trail.jpg
World Wildlife Fund. (2013). from http://worldwildlife.org/
Yeltsin Presidential Library. (2009). “The great stand on the Ugra river” put an end to the Tartar yoke. from http://www.prlib.ru/en-us/history/Pages/Item.aspx?itemid=315
YSI. (2013). EXO2 Water Quality Sonde. from http://www.ysi.com/productsdetail.php?EXO2-Water-Quality-Sonde-90

Appendix A – Map of Ugra National Park (The Ministry of Natural Resources and Environment of the Russian Federation, 2013a)

Appendix B – Map of Ugra National Park with Sampling Locations (The Ministry of Natural Resources and Environment of the Russian Federation, 2013a)



Appendix C – Sophisticated Data Collection

Upon arriving in Russia, the IQP took a different route than what was expected. The project focused more on the tourism of the park and discovering if the paper plants were polluting the river. The park administration decided to drop the idea of us helping in the installation of a real time sensor system. The laboratory at which Irina Semenova works is in fact installing a similar system. It still seems appropriate to include some information on the sensor system.

To further help in the decontaminating process, our team will eventually need more data than the single chemical analysis testing provided for us by the Ugra park rangers. It is always best to have as much information as possible when trying to approach a problem, and with our project the way to get that information is through sensors. A sensor system for Ugra National Park would be a significant asset as the rangers could continually monitor the constituents in the water. Water quality sensors come in many different forms depending on their intended use. Our case would call for a sensor with a wide array of testing possibilities since there is a plethora of pollutants contaminating the Ugra River. As such, a sensor like the "EXO2" could provide the park with a sufficient scope of data. The sensor measures a significant range of quantities including the value of pH and even detecting the presence of Blue Green Algae. The creator of this technology is a global company known as YSI and they have 65 years of experience in hydrological monitoring (YSI, 2013).

Figure 34: Cut away of the internal components of the YSI EXO2 Sensor (YSI, 2013).

Paired with EXO2, the "Storm 3 data logger" would provide the data logging that is required for this water monitoring system. WaterLOG is the creator of the Storm 3 and both WaterLOG and YSI are part of the Xylem brand. The Storm 3 comes with local data logging (storing data on internal memory storage), WiFi and USB connections for grabbing data from the device in the field, and the Storm 3 can be equipped with a cellular radio antenna, a point-to-point radio antenna, or a satellite radio antenna allowing the device to upload it's data to a remote location where the data can be processed. WaterLOG also provides powerful software for the Storm 3 that sorts, logs, and graphs the data that it receives from the data logger and can be configured with alarms for uncharacteristic changes in the data (LOG, 2013).

Figure : WaterLOG Storm 3 data logger (LOG, 2013).

The sensor system will consist of devices placed throughout the park at major tributaries that lead into the Ugra River. The plan is to set up a network for the park so that the park rangers can check the status of the water coming into the river at any time. This would be done through the use of cell phone signals already put in place in the area. The companies YSI and WaterLOG, both a xylem brand, would help us with the logistics of the process. YSI specializes in water sensors and WaterLOG specializes in data loggers for instruments such as the water sensors produced by YSI. Together, both companies make a real-time water monitoring system possible so working with them will be crucial. The sensors themselves will be placed directly into the river and will be able to monitor the quality of the water twenty-four hours a day, seven days a week; however, the sensors can be tuned so that they take different readings throughout the day at specified intervals.

We intend to present a plan for the implementation of the water quality sensor system to the Ugra National Park administration. This plan will include quotes for cost as well as methods for implementation and maintenance of the system. We will possibly try to get the paper companies (the owners of the paper factories in the area that are suspected of unintentionally polluting the river) to sponsor the program and allow them to put their name on the project as good public representation of the morals and values of the company.

Figure 35: Example of what an installed system would look like in the field (YSI, 2013).

If possible, we also plan to help the park rangers in installing a preliminary sensor setup using the scientific method. This would involve two sensors placed at strategic locations in the Ugra River system. There would be one sensor placed in the river upstream from the tributaries that are suspected of polluting the river. This initial sensor would represent a control for the data. The second sensor would be placed within the tributary where the suspicion of pollution is the greatest. This would be the test sensor. We would help set the software for the sensors and help explain how to use the software to the employees. This would be the first step in setting up the water monitoring system for the park. If this trial is successful, then the park could move forward and install more sensors according to the plan that would be created by our team.

Figure 36: Example of how an EXO2 would be installed in the Ugra River (YSI, 2013).

Appendix D – Professor Jeanine Plummer Interview

Director of Environmental Engineering at WPI

Questions

1. Is there a basic test for contamination in water?
    - Chemical or bacterial

2. What would the normal chemicals be in a natural body of water?

3. How do we remove the contamination?

4. Do you know of past ways people have gotten dumping to stop?
    - Threats?
    - Public shame?
    - Increase in severity of punishment?
        - Money?
        - Time? – Force them to help clean up the park

Summary of Interview

- In the U.S. textile industry, a company must have a permit to discharge waste
    - Permits are really well laid out with specific limits
    - Permits are individual for every industry
    - There are allowances in the permits for fluctuations in waste dumping (different levels of waste allowed to be dumped weekly vs. monthly vs. daily)

- Some of the potential concerns about waste from a paper plant are chlorine and organic matter
    - The pulp from the paper factory could increase the organic matter in the river to harmful levels in which would increase the bacteria levels
        - The bacteria would degrade the organic material naturally but the oxygen levels would drop in the water making the environment unlivable for fish
        - This more of a U.S. concern however

- It is not practical to clean the river once it is polluted because it would be too expensive and it would require continual maintenance

- It is more useful to try and change the policies in order to make the companies change their practices
    - This can be accomplished through raising public awareness

- If the paper mill is polluting, then your project should ask why are policies not in place to prevent this.

- Some possible tests that can be performed include color strips, lab tests, and field kits all varying in price.

Appendix C – Travis Pritchard Interview

Water Quality Lab Manager at San Diego Coastkeeper®

Questions

1. What is the best way of testing water quality that you've found?

2. What is the highest/lowest acceptable pH level for livable marine life?

3. Have you ever dealt with paper factories before?

4. Do you know what type of pollutants would come out of paper factor?
    - We would like to suggest a method of recycling their chemicals
        - Have you ever done anything like this/know of someone we could talk to about it?
        - Is it possible to reuse the chemicals?

5. Have you ever used chemical testing trips?
    - Are they accurate enough for our purposes?

Summary of Interview

1. Should test for E. coli. You have to culture but it is relatively inexpensive
    - Should test PH near the paper factories. Between 6-8 is allowable for PH but every river is different
    - You have to figure out the normal conditions for organic matter in the river
        - There will probably be a high level of organic matter in the river

2. Here is some advice on reaching out to the public about water quality
    - Nobody cares about PH.
    - You have to figure out the story the data is telling.
    - Emphasize the economic impact the river has on the surrounding area.
    - Organize a community meeting with pamphlets.
        - This is an opportunity to figure out what the community thinks is important about the river

3. Real time sensors are expensive.
    - They require lots of maintenance.
    - They can communicate through cell phone signals or through radio signals
    - YSA is the gold standard when it comes to water sensors.
        - USGS uses them
        - Their sensors have data logging so data does not get lost if it does not make it over the network
    - Should get in contact with the WaterKeepers.
        - There are seven organizations in Russia

4. Should take water samples as early as possible
    - Should work way up and down river to pin point the source of pollution.

Appendix E – Polotnyano Factory Paper Mill Employee Interview

Blinova Ludmilla Aleksandravna
Chief Technologist at Polotnvano

Questions

1. What is the history of the plant and what is your role in it?

2. Given that you are close to the national park, are there any special precautions/measures that you take?
    - Has the company ever attempted to address this?

3. Dumping?
    - If yes, does it bother you?
    - Are you looking for other methods?

4. If chemicals do go in river, do you neutralize them in some way?

5. If there is evidence of pollution, would you change things?

Summary of Interview

1. The paper plant is 295 years old and it one of the first factories in Russia. It was created under Peter the Great originally to create sails. The factory was repurposed for paper and the paper created here is of a very high quality. Cardboard manufacturing is included too. The factory produces 4000 tons of paper per month. They utilize thrown away paper in their paper making process. During the Soviet Union, the factory and one other factory were granted the rights to new construction. When it came time to commence the new construction, the Soviet Union was failing but that did not stop the new construction.The factory is in the vicinity of a village. The factory is part of the museum next door and the factory itself is even a monument.

2. The factory does take special precautions to make sure the waste from the factory does not harm the river

3. The factory uses very few chemicals. They use some modified starch. The recycled paper they bring in is very dirty and they use bacteria in special baths to clean the paper.

4. The factory does neutralize the waste before dumping it into the river. The chemicals that the factory uses destroy themselves so almost no chemicals end up in the river.

5. According to the laws of Russia, they need to clean everything they dump into the river. The factory tests the water quality of the water being dumped, the water upstream from the factory, and the water downstream from the factory

Appendix F – Tzoitsk Paper Factory Employee Interview

Likhachova Tatiena Yuzievna
Environmental Engineer at Tzoitsk

Questions

1. What is the history of the plant and what is your role in it?

2. Given that you are close to the national park, are there any special precautions/measures that you take?
    - Has the company ever attempted to address this?

3. Dumping?
    - If yes, does it bother you?
    - Are you looking for other methods?

4. If chemicals do go in river, do you neutralize them in some way?

5. If there is evidence of pollution, would you change things?

Summary of Interview

- A lot of acid is used during the paper making process. All the acid is dumped after use, but the paper plant takes measures to neutralize the acid in the waste. There are more expensive ways of recycling the waste, but the company does not have the resources for this so they pay the government more in order to dump chemicals into the river. The company sees it as more profitable to pay the fines rather than installing an expensive recycling station. The company has new owners and the new owners do not care about the environment as much as the old owners did. There are very few waste removal companies in Russia because of the limits that the government places on these types of companies. The new parent company of this factory is going bankrupt and does not care about this factory so it seems as though the factory will be closing in a few years.

- 30 years ago, the company was working with the acid and did not know the environmental effects of the acid. The building started to fall apart because the acid was degrading the building. The acid began seeping into the ground and getting into the river.

- The company built a new building and now the factory is safe and the waste is completely automated whereas before it was dependent on the workers.

- The acid is now reused by the factory up to 6 times.

- The problem is not the factory, it is the city.
    - The water that comes downstream to the factory is very dirty.
    - There is no biological cleaning at the factory.
    - The factory cleans the dump water of the entire city.
    - The people living in the city are to blame.

Appendix G – Laboratory Technician Interview

Irina Semenova
Leading Scientific Specialist
Research and Production Association "Typhoon"

Questions

1. How do you do your testing (where, how often)?
2. What substances do you test for?
3. Do you conduct any biological tests?
4. Do you test specifically for *E. coli?*
5. Do you think something is wrong with the river?

Summary of Interview

1. There are special locations that the lab gets its water samples from
    - There are 2000 different locations along the river.
    - The Lab runs the tests 6 times a year.

2. The lab tests for about 10-20 different substances
    - Examples: Calcium, magnesium, sulfates, nitrogen, phosphorous, silicon, mercury, iron, cobalt, nickel, oxygen levels, and carbon-dioxide levels

3. The lab is equipped to test for a few different types of bacteria but usually don't

4. The lab cannot test for *E. coli*.

5. "Ugra is one of the clearest rivers in the region"

- Another organization tests the river to determine if it is healthy enough for people (swimming)
    - The city uses their own organization for these purposes.

Appendix H – Environmental Lawyer Interview

Kazannikov Yuri
Environmental Lawyer
Questions

1. What is your role in the national park?

2. Are there laws protecting the Ugra River from pollution?
    a. If so, what are they and how are they enforced?

3. Are there regulations on how much waste companies are allowed to discharge into the river?
    a. If so, how are these laws enforced?

4. Are the laws different when it comes to protecting the tributaries that feed into the protected river?

5. Are there any government incentives for companies to go green?
    a. Is the public opinion in favor of a more environmentally conscience company?

6. Do you have specific things on the wish list for us? What kind of methods for raising public awareness would have the most success?

Summary of Interview

- There are few other organizations which deal with as many problems as a national park, at least in a legal sense. The role of a lawyer within a national park is very important because the purpose of a park is to defend nature and the greatest tool the park has is the legal process. In the 90s, parks gained more of the public's attention and put more emphasis on science. Now parks talk to each other through committees and meetings.

- The science is very important but so is working with the government. The two need to work together in order to accomplish the primary goal of protecting the park. There was a time when the cleaning equipment that the city used in the koentsk region (cleaning waste) was not meeting the demands of the city. An inspector came in and followed a stream to determine the source of the pollution. Once the inspector provided the scientific evidence, the lawyers took the culprits to court and successfully proved that they were at fault for the pollution forcing them to pay very large fines.

- It is very hard to make someone pay for violations in courts because the courts and policemen are biased against the park.

- 80% of violations are caught by people not affiliated with the park calling in violators (illegal fishing, using nets and explosives, tainting rivers with trash, etc).

- A worldwide problem that national parks face is forest fires. Ugra National park takes precautions to prevent fires (digging trenches to make it hard for the fire to spread, removing fallen trees, maintaining roads to river for fire trucks). They haven't had much of a problem with forest fires because of the precautions they take and the locals will call in any signs of fire.

- In the past year, the media reported that the Ugra River was dirty due to the pollution of the city of Yuknov. The city was polluting the river with a steady stream of dirty water. Because the of the media coverage, the problem was resolved very quickly.

- National Parks have one lawyer if that. This makes it very hard for national parks to fight for their parks in the legal system. National Parks are nonprofit organizations and are not in the business of making money; they are good at protecting nature but not at making money. Too many lawyers are just concerned with making money.

- People respect policemen but not park rangers because the idea of a park ranger is so new. Rangers are mostly just local people hired to work for the park. There is a small amount of training but there isn't an extensive training park like what happens in the U.S. Those that have worked for the park for a long time are very good because of the experience that they have gained.

- There are no government incentives for a company to go green.

Appendix I – Ugra National Park Director Interview

Victor Grishenkov
Park Director of Ugra National Park

Questions

1. Could you describe the history of the park and your role in it?

2. Why do you think it is important to have a clean, healthy park?
    a. Are the populations of animals, fish, and plants at a healthy number?
        i. Are their numbers increasing or decreasing?

3. What part of the area do you think is the least pristine and why, what is happening there?

4. Do you suspect that there are multiple tributaries bringing in contamination?
    a. Is the paper factory runoff alone the main contributor or do you believe that there are multiple sources of the pollution?
    b. What could these other sources be?

5. How do you know there are contaminates?
    a. Sight?
    b. Presence/absence of wild life (fish included)?
    c. By test?
        i. What is your current method of detecting contaminates within the river?
        ii. Could we get more information about this lab?

6. Are you interested in a water monitoring system?
    a. Would it be beneficial to have this data on a regular basis?
    b. What is the most important factor in choosing the appropriate water monitoring system? (cost, size, maintenance, possible tests, data collection method, winter maintenance/storage)

7. Have you ever looked into removing the waste before?
    a. What were your methods of removing the waste and how successful was the venture?

8. Why do you think the park would benefit from making the public aware of the pollution problem?
    a. What is the optimal outcome of the actions?

9. Has there been a public campaign about the pollution of the Ugra River in the past?

10. What would you think would be the most affective public awareness method to protect the park? (Pamphlet, presentation, legal action, advertising materials, public meeting/forum, educational effort)

11. Has a similar pollution problem occurred in any of the other rivers of Russia?
    a. If so, how did they handle it?
    b. What can we learn from their experience? Can we get a report about it?

12. Out of all of the options presented, what do you think we should focus on? What would the next step be?

Summary of Interview

- Manager for 3 months. Scientists came up with the idea to create Ugra National Park about 30 years ago. Regulations made it hard to create the park but with the help of government and scientists, the park was created. The park was established in 1997. Locals were not happy because the park made hunting illegal and restricted expansion of villages.

- Victor worked in the park since 1999. He works to protect the park and because its proximity to Moscow, many people come to visit.

- Important to have clean, clear water. It is Victor's belief that in years to come, clean water will be more valuable than oil.

- They have specialists test flora and fauna. Special Russian rare animal, the Russian Desman, they thought was going extinct but specialists were able to determine promising life of the animal. The animal still needs help to live and if the park administration can't help this animal, then they are useless and a waste of money.

- Every area of the park is very important. The park needs a lot of work concerning tourists (trails, etc.)

- Ugra Park suffers from pollution in other areas besides the paper plant areas because the park is in a very industrial area. The difficult aspect is that the companies do not reside within the park making it difficult to enforce laws and regulations upon them.

- Other pollutants include city water and agricultural farms (locals complained about smell of water. In this case they didn't need analysis. With help, they are creating new cleaning stations)

- Industries and cities are the biggest pollution offenders

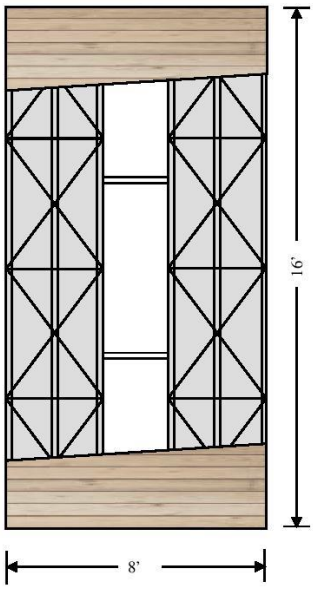
Appendix J – Water Test Results

Sample #	Lignin (mg/L)	Chlorine (mg/L)	Observations
1	0.5	0	Clear,no obvious signs of pollution
2	0.5	0	Clear,no obvious signs of pollution
3	0	0	Clear,no obvious signs of pollution
4	0	0	Clear,no obvious signs of pollution
5	0	0	Clear,no obvious signs of pollution
6	0	0	Clear,no obvious signs of pollution
7	0	0	Clear,no obvious signs of pollution
8	0	0	Foul odor coming from the water, murky color
9	0.5	0	Lots of trash littering the area, murky water

Appendix K – Floating Dock Kit (Dock Builders Supply™, 2013)

DOCK BUILDERS Supply
P.O. Box 3450
Apollo Beach, FL 33572
Tel: 800.677.4710

DOCK SKETCH	Canoe / Kayak - Floating Dock Kit	
Dimensions:	**8' x 16'**	For shipping/freight costs and transit times to your location, please call or e-mail: **(800) 677-4710** **sales@dockbuilders.com**
#/Size of Stringers:	(6) 2" x 8" Stringers	
Decking Size:	2" x 6" Decking	
Decking Type:	P.T. Lumber	



36" x 48" x 8"
Dock Float (FD-3408)

FLOTATION SUMMARY

(8)	FD-3408 Dock Floats (36" x 48" x 8")
(48)	LB-3804SS (3/8" x 4" Stainless Steel Lag Bolts)
(48)	W-38SSF (3/8" Stainless Steel Fender Washers)

FRAMING HARDWARE (HINGED) SUMMARY

(4)	Outside Corners – End
(4)	Inside Corners
(12)	Angles (2 per internal stringer / blocking)
(24)	Washer Plates (4 per internal stringer / blocking)
(80)	Carriage Bolt Sets (1/2" x 3" bolt/washer/hex nut)

LUMBER SUMMARY (Not Included in Kit)

(2)	2" x 8" x 8' Fascia / End Boards
(6)	2" x 8" x 16' Stringers / Joists
(34)	2" x 6" x 8' Decking Boards (Approx)
	Extra 2" x 8" x 10' stringers required for 5/4" decking
	Extra 2" x 8" lumber required for internal blocking.

OPTIONAL ACCESSORIES

* Safety Bumper / Flip-Up Cleats
* Floating Dock Ladder
* Pipe Holders / Chain Retainers

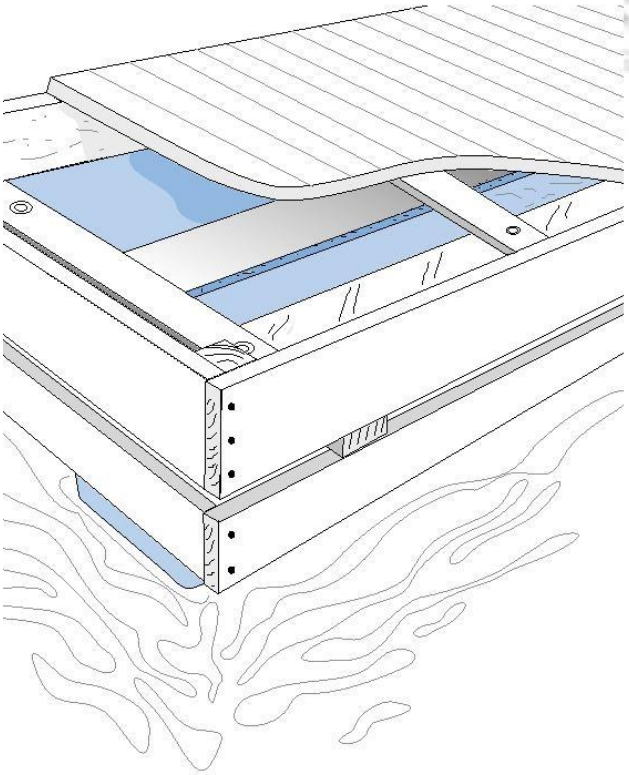
Note: Dock Builders Supply assumes no responsibility or liability for the design, structural integrity, accuracy or completeness of this sketch/drawing. Sketch is provided as a guide-line only. Dimensions are approximate. Internal stringer blocking over the perimeter of dock floats is not shown, but should be incorporated throughout the frame to provide additional dock float mount points. Dock floats should be on-hand during construction to use as a templates to accurately align internal stringers over the perimeter of floats. Lumber is not included in dock kit and must be acquired locally.

Appendix L – Instructions on Building a Floating Dock (Dock Builders Supply™, 2013)

Plans For Build-It-Yourself

FLOATING DOCKS, RAFTS AND BOATWELLS

With STYROFOAM* Brand Buoyancy Billets



DOW STYROFOAM BB BUOYANCY BILLETS

*Trademark of The Dow Chemical Company

STYROFOAM* BRAND BEAT ANYTH

Extremely Buoyant

STYROFOAM* brand buoyancy billets are one of the best materials to use for floating structures such as these. This extremely buoyant, yet durable material is composed of millions of tiny non-interconnecting air cells, each serving as an independent buoyancy chamber. It takes only one cubic foot of STYROFOAM brand buoyancy billets to float 55 pounds.

Rugged

STYROFOAM brand buoyancy billets won't lose their buoyancy, even if punctured. The light weight of STYROFOAM brand buoyancy billets reduces the racking of the wooden framework of a floating structure, and helps minimize damage from storms. Rocking, usually experienced in drum-floated structures, is greatly reduced by using STYROFOAM brand buoyancy billets – and there are no hollow drumming noises to listen to at night.

2

*Trademark of The Dow Chemical Company

BUOYANCY BILLETS ING AFLOAT!

Durable

STYROFOAM brand buoyancy billets stay on the job year after year under normal conditions. They do not waterlog or corrode. They resist the attack of destructive marine growths and are unaffected by salt or fresh water. Because of their light weight, these billets are easier to handle and install, too, keeping installation costs low!

Wooden portions of your floating structure can be subject to decay and insect attack. For the protection of such portions, use only treated wood or wood naturally resistant to decay and insect attack. Treated wood should be clean, dry, and free from oil residue.

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Replacing Existing Drums

You can easily replace drums with buoyancy billets while a floating structure is still in the water.

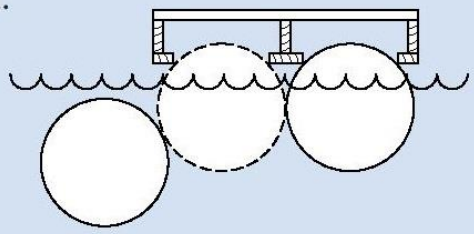
Note: one 10" x 20" x 8' STYROFOAM* brand buoyancy billet has an average buoyancy approximately one and a half times greater than a 45 gallon drum. Locate replacement billets of foam 10 to 15% closer together if the buoyancy provided by the drums proved barely adequate.

Table 1 – Comparative Size and Buoyancy Data

BILLET SIZE	CUBIC FEET	APPROXIMATE WEIGHT (lbs.)	APPROXIMATE BUOYANCY (lbs.)
7" x 20" x 8'	7.7	14	425
10" x 20" x 8'	11.1	20	610
†7" x 20" x 9'	8.6	16	480
†10" x 20" x 9'	12.5	23	690
†10" x 24" x 8'	13.3	24	730
45 Gallon Drum, 18 ga.10	7.82	48.5	440

†Available in the US only.

1.



Sink and remove two drums at a time. Build a crib (2 x 8's suggested) and fasten it to the …

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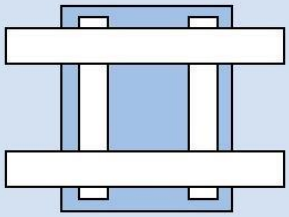
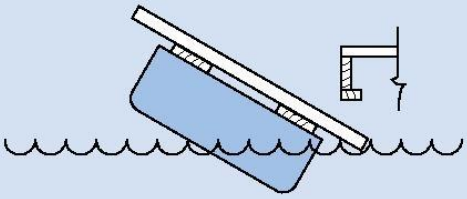
2.



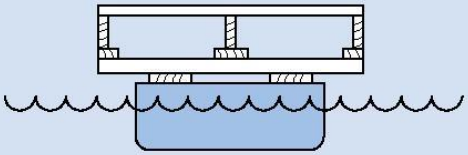
STYROFOAM* brand buoyancy billet. Cross members should be longer than wharf is wide.

3.



Tilt crib; push under wharf using the 2 x 8's as handles.

4.



Center under wharf. Secure with 16d nails. Saw off protruding 2 x 8 handles.

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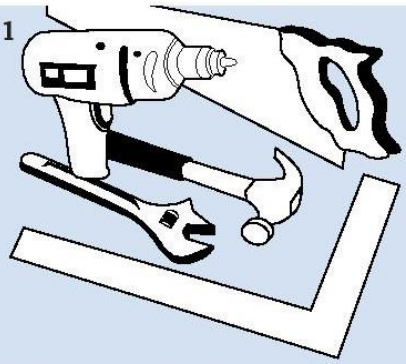
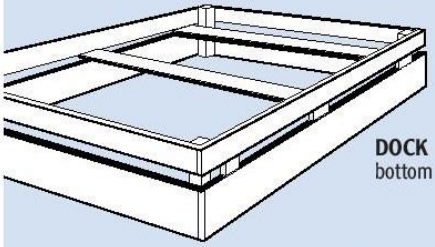
Step by Step Construction

Step 1



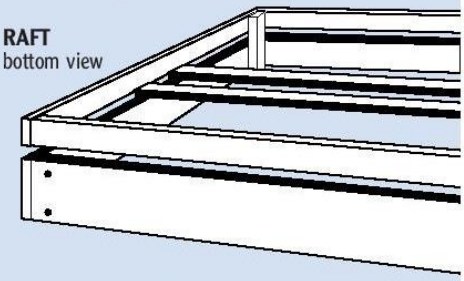
Gather the five tools shown above.

Step 2



DOCK
bottom view

RAFT
bottom view



With frame structure upside down, nail on cross ties and "skirt" boards. Three cross ties are required for the dock, four for the raft. See assembly design for construction of the boat well.

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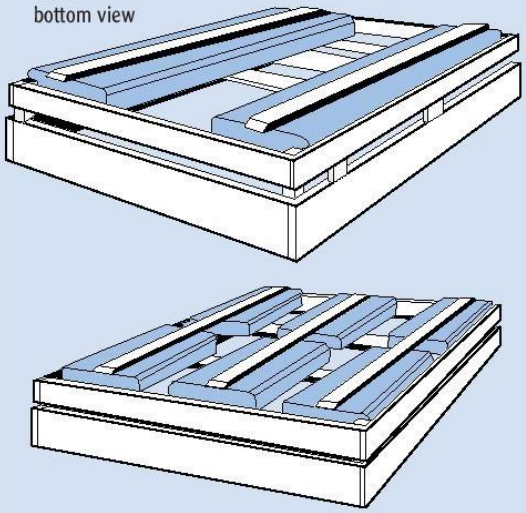
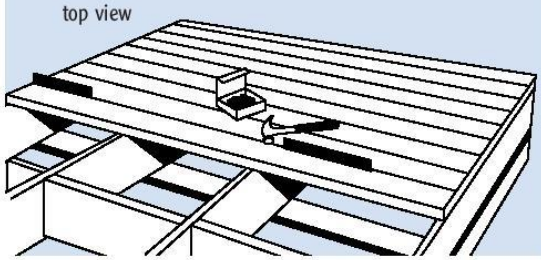
DOCK
bottom view



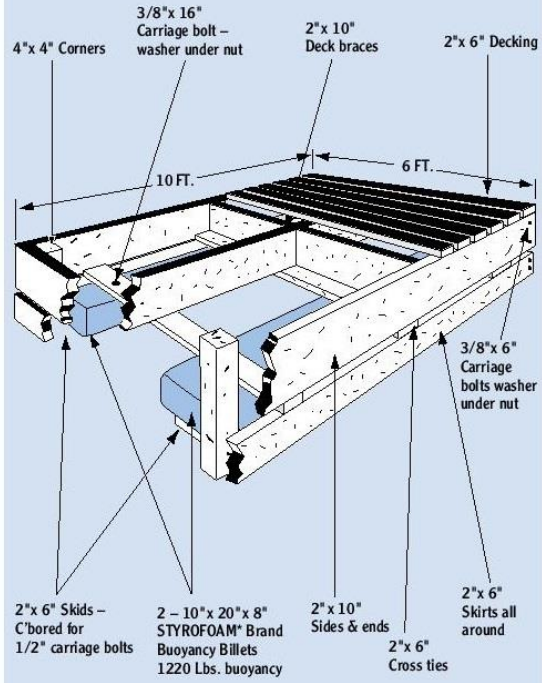
After laying STYROFOAM* brand buoyancy billets across the cross ties, place skids on the foam; drill holes through skids and cross ties; insert bolts; reach under to apply washers and nuts.

After inverting the structure, tighten nuts to a snug fit. Install lengthwise bracing first, then cross bracing. Nail on dock boards using a piece of 1/2" plywood to space boards 1/2" apart.

RAFT
top view



Build-It-Yourself Plan For Floating Dock



† This plan is for one section of a floating dock. Additional sections can be made to increase the length of the dock to the builder's desire.

Note: 3/8" Galvanized bolts may be replaced by a threaded rod cut to the required length.

(6' x 10')†

Table 2 – Materials for Dock

PART NAME	SIZE	QUANT. REQ.
Sides	2" x 10" x 10'	2
Ends	2" x 10" x 5'9"	2
Deck Braces	2" x 10" x 9'9"	1
Deck Braces	2" x 10" x 2'9½"	2
Skirts	2" x 6" x 10'	2
Skirts	2" x 6" x 5'9"	2
Cross Ties	2" x 6" x 6'	3
Decking	2" x 6" x 6'	20
Skids	2" x 6" x 9'	2
Corners	4" x 4" x 16½"	4
Bolts with Nuts	3/8" Dia. 16" Lg. Galv. Carriage	6
Bolts with Nuts	3/8" Dia. 6" Lg. Galv. Carriage	16
Nails	3½" Galv.	6 lbs.
Washers	3/8" Galv.	22
STYROFOAM* brand buoyancy billets	10" x 20" x 8'	2

*Trademark of The Dow Chemical Company

Build-It-Yourself Plans For Swimming Raft

Table 3 – Materials for Swimming Raft (8' X 12')

PART NAME	SIZE	QUANT. REQ.
Sides	2" x 10" x 12'	2
Ends	2" x 10" x 7'9"	2
Deck Braces	2" x 10" x 11'9"	2
Deck Braces	2" x 10" x 2'6"	3
Skirts	2" x 6" x 12'	2
Skirts	2" x 6" x 7'9"	2
Decking	2" x 6" x 8'	24
Cross Ties	2" x 6" x 8'	4
Skids	2" x 6" x 11'2"	3
Corners	4" x 4" x 16½"	4
Bolts with Nuts	3/8" Dia. 16" Lg Galv. Carriage	12
Bolts with Nuts	3/8" dia. 6" Lg Galv. Carriage	16
Nails	3½" Galv.	6 lbs
Washers	3/8" Galv.	28
STYROFOAM* brand buoyancy billets	10" x 20" x 8'	3

NOTE: 3/8" Galvanized Carriage bolts may be replaced by a threaded rod cut to the required length.

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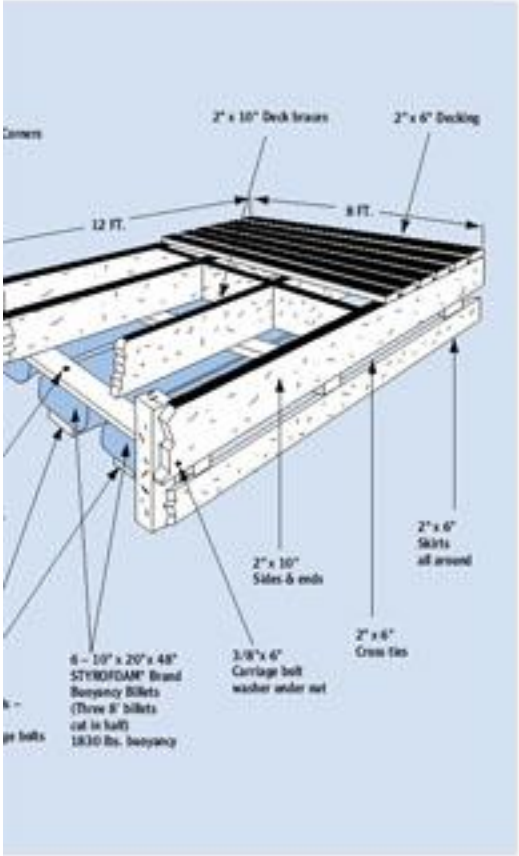
(8' x 12')



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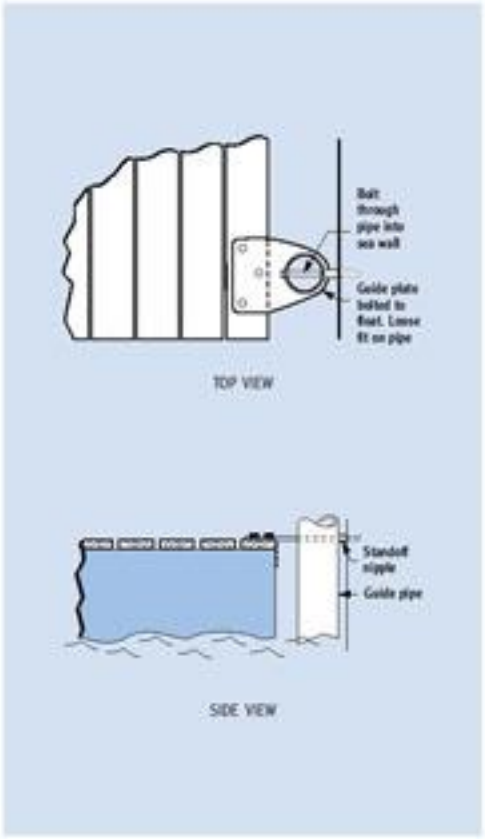
How To Secure Floating Docks & Rafts

Dock To Seawall For Tidal Variation



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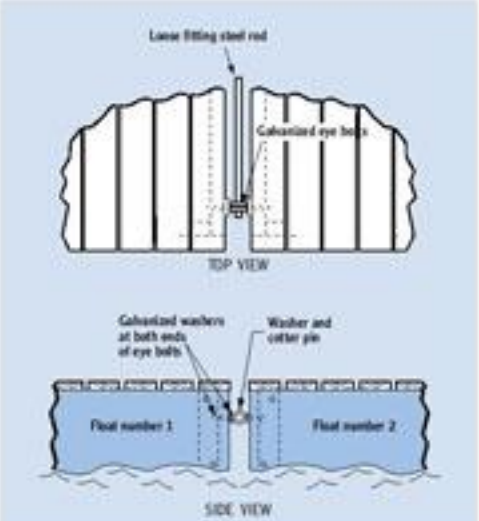
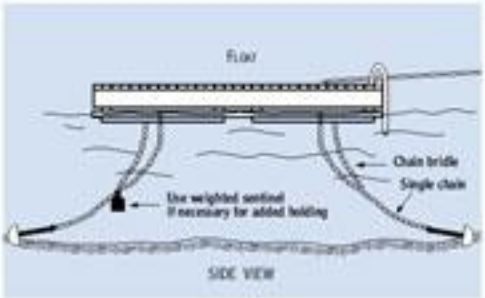
How To Secure Floating Docks & Rafts (Continued)

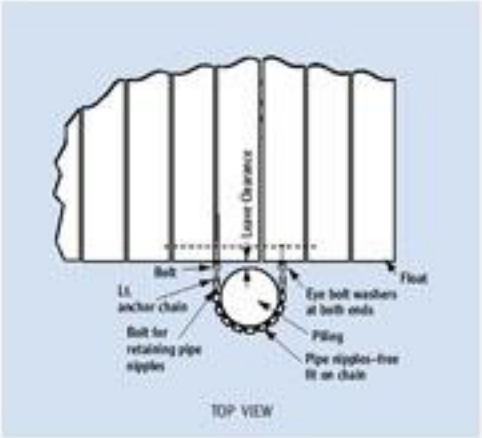
Dock To Dock



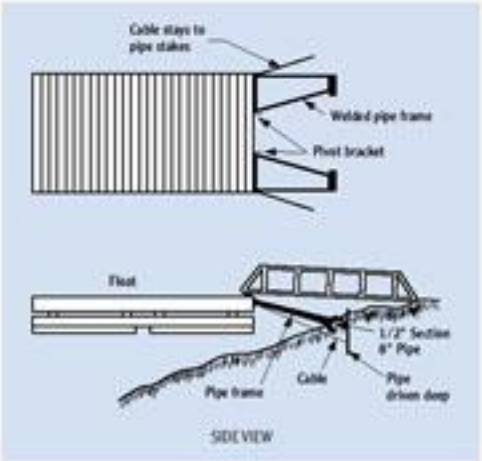
Raft To Bottom



Dock to Piling for Tidal Variation



Dock to Shoreline



Precautions:

STYROFOAM* brand buoyancy billets are sold only for use in marine applications. Care should be taken not to expose material to open flame or other ignition sources.

The foam is subject to attack by some chemicals including concentrated quantities of gasoline and oil. If this, or pollution by industrial waste is suspected, reaction of the foam should be checked prior to construction. Additional protection – such as epoxy coatings (solvent free) – in case of extreme pollution may be required. Compatibility of the coating to the billet should be checked prior to applying the coating. Skirt boards will protect foam from mechanical damage and ultra-violet light degradation.

*NOTICE – No freedom from any patent owned by Seller or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer's use and for ensuring that Customer's workplace and disposal practices are in compliance with applicable laws and other governmental enactments. Seller assumes no obligation or liability for the information in this document. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

Published March, 1997.

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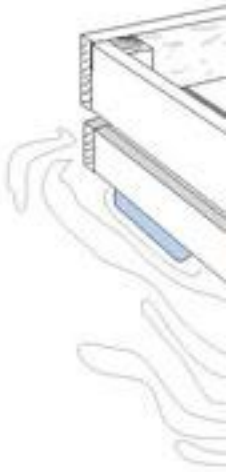
For more information on
STYROFOAM* Brand buoyancy billets, call:
1-800-441-4369 in the U.S.
1-800-363-3500 in Canada



DOW STYROFOAM* BB BUOYANCY BILLETS

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Appendix M– Previously Recorded Data Provided by Ugra National Park (Semenova, 2007)

ДАТА	Q	t	O2	pH	Ca	Mg	HCO3	SO4	Cl	NO3	NO2		PO4	Si
8/21/1938	5	21.2		7.3	59.2	12.4	241.5	15.3	6.5		0.005	347	0.16	
11/24/1938		3.6		7.5	69.4	12.4	265.9	16.7	5.7		0.003	380	0.13	
3/26/1940	40.8	0		7.1	62	8.8	198.3	23.1	3.9	0.42	0.001	298	0.11	
4/20/1940	1480	4.2		7	11.9	1.5	42.7	4.9	1.5	0.11	0.003	66	0.2	
9/21/1940	25.7	14		7.4	68.1	12.3	244	17.6	5.7			351	0.05	
3/13/1941	28.1	0		7.3	69.6	12.8	280.6	18.2	3.2	1.24	0.006	401	0.15	
2/22/1951	21.8	0		7.1	84.3	15.1	323.3	10.2	5	1.72		445.4		2.1
3/30/1951	1580	1.2		6.9	14.1	2	43.5	5.6	3	0.92	0.05	70.6		1.3
4/9/1951	415	6.5		6.9	20.7	3	74.6	5.8	3	0.69	0.01	111.6		2.5
4/26/1951	105	9.6		7	43.9	8.5	161.6	7.9	3	0.69		225.8		1.6
11/11/1951	19.8	0		7.2	80.7	17.3	304.6	28.4	7	0.92		447.4		3.6
12/23/1951	26,0/87,4	0		7	71.2	13.1	261.1	16.4	5	2.2	0.01	373.2		4.1
3/25/1952	25.1	0		7	83.3	15.8	304.6	14	6	1.26		425.2		5.6
4/18/1952	1557	0.2		6.8	14.4	3	49.7	7.6	2	2.75		82.2		3.2
7/19/1952	36.6	22.2		7.2	63.2	9.6	180.3	46.2	5	0.67	0.002	308.2		3.6
10/27/1952	163	4.2		7	33.9	6	124.3	11.4	3	0.34		183.7		
12/10/1952	42,0/49,2	0		7.2	71.8	10.4	248.7	13.2	4	0.8	0.01	349.7		3
1/25/1953	32.8	0			87.3	13.1	267.3	41.8	6	1.83	0.01	417.5		2.8
5/29/1953	59.2	15		7.38	62.8	7	192.7	23.8	2	0.91		289.7		3.8
6/30/1953	56.6	19.4			40.2	6.6	149.2	7.1	2	0.57		208.7		3.3
8/25/1953	44.2	22.6		7.4	57.4	9.9	217.6	8.6	3	0.23		300.7		2.4
11/30/1953	48	0		7.35	69.5	14.4	279.8	12.4	4	0.92	0.002	389		4.1
12/26/1953	33,2/102	0		7	72.7	10.1	248.7	34.3	7.1	4.45	0.025	382.4		4.7
1/23/1954	22.7	0		7.18	89	14.1	292.2	31.9	7.8	1.37	0.045	438.6		3.7
6/29/1954	25.2	23.6		7.45	66.3	12.5	242.5	17.8	5	0.56	0.002	348.7		3.6
7/20/1954	22.6	23.8			62.9	13.8	242.5	19	5	0.45		350.2		4.2
11/28/1954	30.2	0		7.59	67.5	12.2	243.9	15	4	0.82	0.015	344.9		4.1
12/20/1954	29,6/70,5	0			79.5	14.2	292.7	14.8	5	1.23		410.6		3.9
2/20/1955	41.1	0			59.5	9.6	219.5	10.7	4	1.15	0.005	309.3		4.8
5/19/1955	105	14.5		7.25	47.9	7.7	170.7	10.2	2	0.57		240.6		4.1
8/19/1955	27.7	19.8			63.7	11.4	231.7	17.3	4.8	0.23		333.6		3.5

9/24/1955	29.7	12.6		7.59	64.3	14.1	250	15.4	4	1.37		353.7		2.8
11/29/1955	27,8/96,5	0			83.8	15.1	280.5	36.2	4	0.8		421.6		3.7
1/16/1956	22.5	0			81.3	14	298.8	16.2	5	1.15	0.002	421.3		8
4/19/1956	819	0.8			14.1	2.5	42.7	7.8	1.5	1.37	0.002	70.2		3.4
4/22/1956	1760	3.8			15.8	2.9	42.7	10.4	3.5	1.2	0.01	76.7		
5/4/1956	192	12.2			37.9	5.6	121.9	16.3	3.1	1.2	0.015	188.5		3.4
7/25/1956	28.2	18.4			64	12.7	242.9	16.8	4.5	0.34		347.2		2.8
9/28/1956	28.2	6.9			67.7	12.8	250	11.9	3.9	0.12		347.2		1.9
12/27/1956	42,4/83,3	0			62.3	11.3	231.7	10.4	3.9	1.15		323.6		4.6
2/23/1957	66.5	0		7.4	63.7	10.5	225.6	17.1	4.9	0.69		326.7		3.7
4/4/1957	270	0			30.1	4.8	103.7	9.1	2	0.68		151.9		3.1
4/11/1957	938	1.2			17.8	3.3	54.9	9.4	2	1.03	0.005	88.9		3.9
4/24/1957	400	10.2			23.8	3.6	73.2	15.5	3.9	0.81		124.6		3.8
6/8/1957	66	18.5		8.8	48.5	8.2	170.7	7.7	4.9	0.68		241.2		3.3
9/13/1957	27.6	17.4		8.4	71.8	12.7	256.1	17.3	6.1	0.22		367		1.4
12/18/1957	32,3/95,2	0		7.2	77.5	13.9	292.7	16.5	4.1	1.8		413.5		2.3
3/16/1958	64.8	0			63.2	11.6	225.6	16	5.1	0.88		324.4		5.2
4/15/1958	886	0.2			17.8	3.3	54.9	11.4	4	0.45	0.024	94.4		3.5
4/21/1958	1960	4.4			16.9	3.3	48.8	10.4	3	1.1	0.02	83.7		2.5
11/14/1958	53.5	0			63.2	10.6	201.2	26.7	6	0.56		308.8		5.5
12/9/1958	33,1/141	0			82.7	13	280.5	28.4	6	0.66		415.5		5.8
4/13/1959	1510	4.3			14.4	2.1	42.7	14.6	0.6	1.03	0	79	0.057	3.2
6/19/1959	31.6	17.4		7.55	66.2	11.7	264.1	19.5	3.8	0.05	0	379.8	0.047	4.2
8/21/1959	21.4	19.2		8.15	59.4	17.7	239.7	28.7	1.5		0	350.8	0.003	2.6
10/30/1959	33/80,3	2.8		6.25	77.1	13.6	211.1	79.8	7.1	0.1	0.009	297.8	0.131	4.8
3/10/1960	25.8				78.5	14.2	296.5	23.4	6.3	1.25	0.003	431.8	0.031	8.7
4/13/1960	560				16.7	3.4	53.7	16.6	2	0.95	0.014	98	0.004	2.3
4/16/1960	1130				13.5	3.6	40.9	20.2	2.2	0.78	0.004	86.2	0.035	2.6
4/22/1960	334			8.3	22.7	5.2	67.7	31.8	2	1.05	0.003	137.7	0.082	4.7
6/9/1960	30.6	20.5	7.4582	8.05	61.2	12.9	231.8	16.9	2.6	0.13	0.001	328.3	0.007	2
10/28/1960	71.1	0.8	2.7119	7.7	57.4	11.1	217.2	16.6	4.6	0.21	0	313.4	0.011	4.1
12/20/1960	105/86,7	0.5	12.9991	7.7	39.5	8.6	126.3	24.8	4.2	0.53	0.001	204.7	0.034	5.3
3/21/1961	425	0.3	14,11/99	7.4	23.8	5.2	77.5	19.6	2.4	0.008	133.2	0.01	0.019	4
3/31/1961	415	1.5	14,36/104	7.4	19.8	3.8	61.6	16.6	2.5	0.004	107.7		0.045	3.7
4/20/1961	178	8.2	9,46/81	7.6	30.3	5.8	103.1	15.1	1.9	0.004	159.9		0.029	3.5
6/27/1961	32.5	19.5	15,01/162	7.7	64.7	13.2	244.6	23.9	4.9	0	259.1		0.011	3.2

9/9/1961	54	12.4	8,1/76	7.6	60.2	11.8	203.1	33	6	0.001	319.6		0.012	3
11/16/1961	31.3	0	14,55/101	7.7	73.8	13.4	217.2	16.1	5.7	0.85	0.004	334.1	0.014	4.2
12/20/1961	69/85,6	0	10.3772	7.35	43.2	7.5	148.2	26.2	5.1	1.02	0.008	240.3	0.036	5.5
2/20/1962	32	0	8,65/60	7.35	70.7	13.2	271.4	18.2	5.2	0.92	0.008	389	0.01	5
4/7/1962	795	0.8	11,5/82	7	13.1	3.6	46.4	13.5	2.5	1.01	0.038	84.5	0.04	4.1
4/11/1962	1710	3	11,86/89	7	12.4	1.7	35.4	10.7	1.4	1.02	0.006	65	0.046	4.5
4/17/1962	712	7.2	10,5/88	7.2	16.8	3.5	48.2	16.5	1.7	1.19	0.019	89.9	0.057	4.8
5/4/1962	123	11.1	9,36/85	7.9	53	9.7	186.7	21.9	1.4	0.9	0.004	276.8	0.04	4.3
7/17/1962	103	18.6	8,46/9	7.75	51.2	10.4	201.3	12.6	2.8	0.21	0.046	284.4	0.023	4.3
7/27/1962	203	14.5	7,96/78	7.5	36.8	8.7	150.7	11.2	2.8	0.75	0.034	217	0.055	4.4
12/10/1962	148/143	0	1262/88	7.35	50.5	8	177.5	23.9	5.9	1.01	0.004	277.1	0.045	4.3
3/26/1963	28.1	0	7,56/52	7.55	76.1	14.1	286.1	19.3	5.6	0.99	0.004	409.8	0.021	5.4
4/18/1963	431	0.2	11,92/83	7.4	13.2	15	59.8	11.5	4.3	1.17	0.033	102.4	0.036	3
4/21/1963	2170	1.6	12,19/88	7.2	8.9	2.4	29.3	9	2.3	1.16	0.029	55.9	0.044	3.2
5/2/1963	273	10.6	12.92116	7.55	13.1	3.3	95.8	9	3.6	0.99	0.015	127.1	0.04	4
7/5/1963	27.3	17.2	9,26/96	6.95	64.4	12	236.1	17.6	4.3	0.02	0.002	338.4	0.011	3.4
10/30/1963	27.9	4.3	10,49/82	7.55	72.2	13.9	259.2	38.7	5.5	0.07	0.007	401.2	0.002	3.1
11/29/1963	24,8/87	0	12,12/84	7.55	78.8	11.9	248.3	44.9	7	0.73	0.017	399.2	0.028	5.3
3/21/1964	21.4	0	6,34/44	7.35	82.3	15	269.5	57.8	8.6	0.68	0.019	434.4	0.003	6.9
4/15/1964	782	1.4		7.45	15.6	2.7	58	13.5	4.1	1.29	0.026	104.4	0.037	4.8
4/19/1964	1360	2.4	11,28/83	7.15	13.2	2	37.2	13.1	3.9	1.21	0.023	75.4	0.082	3.4
4/27/1964	313	6.5	7,29/6	7.6	24.8	5	78.1	20.4	3.6	0.79	0.007	136.7	0.06	5.8
5/19/1964	61.5	13.8	6,52/63	7.55	46.1	17	190.9	29.8	6.3	0.01	0.002	295.9	0.007	7
7/4/1964	22.1	22.8	9,68/110	7.55	59.3	12	215.3	23.5	6.3	0.03	0.002	322.6	0.002	7
11/10/1964	19,4/64,6	0	9,89/69	7.55	75.5	19.8	270.2	42	7.8	0.1	0.005	418.6	0.019	4.2
3/17/1965	20	0	6,06/42	7.35	80.3	16.9	283	37.8	5.7	1.09	0.01	430	0.004	4.6
4/19/1965	292	2.2	5,34/39	7.1	27.9	5	76.9	21.4	4.3	1.03	0.023	137.8	0.1	0.8
4/22/1965	382	4.2	4,82/37	7.1	22.8	3.5	54.9	24	4.2	1.13	0.019	113.3	0.034	3.6
4/29/1965	142	7.6	9,38/79	7.35	38.5	6.3	102.5	30.6	4.5	1.08	0.021	184.3	0.019	4.2
5/8/1965	71.2	9.5	8,13/71	7.35	50.7	6.7	145.2	34.4	6.7	0.9	0.001	250.4	0.019	3.6
7/31/1965	29.7	17.2	8,41/87	7.95	71.7	12.9	251.9	16.4	5.7	0.04	0.001	358.6	0.003	2.2
10/13/1965	23.2	4.1	9,67/75	8.05	77.7	14.2	278.8	19.7	5.8	0.08	0.001	398.5	0.001	2.8
11/15/1965	19,5/43,6	0.1	10,92/76	7.85	95.2	13.6	293.4	36.7	10	0.74	0.012	449.7	0.004	4
11/26/1966	30.5	0	5.29	7.3	81.3	13.1	277.6	18.1	4.3	0.59	0.012	395	0.009	6.2
4/5/1966	1830	2.6	11.75	7	14.8	2.1	36	15.6	3.7	0.58	0.014	75.6	0.046	3.8
5/4/1966	84.9	11.9	9.78	7.6	56.7	6.9	181.8	18.1	3.9	0.9	0.003	270.5	0.029	2.8

7/20/1966	25	23	9.2	8.15	63.5	14.1	240.3	16.3	6.3	0.25	0.001	344	0.019	2
10/31/1966	26.8	2.3	12.8	8.25	59.5	24.4	276.3	18.6	7	0.2	0.001	405.4	0.056	2.8
11/23/1967	37.7	0	9.02	7.75	86.4	13.2	248.9	18.9	4.2	1.18	0.002	372.8	0.026	5
4/14/1967	1950	2.8	12.35	7	19.2	2.4	44.6	15.3	1.4	1.1	0.014	84	0.065	1.6
5/16/1967	46.4	17.7	6.86	7.85	63.3	10.9	214.7	28.1	5	0.05	0.001	326.6	0.009	2.8
8/16/1967	22.3	21	7.4	7.9	66.1	13	241.6	40.3	7.1	0.05	0.001	384	0.019	2.4
9/24/1967	28.1	12	7.75	7.15	91.4	13	289.1	115.4	7	0.08	0.018	561.2	0.037	6.4
3/14/1968	21.6	0	6.86	7.35	76.6	14.6	278.2	19.6	10.1	0.94	0.007	406	0.002	5
4/4/1968	1320	1.8	11.95	7.35	16.4	3.3	40.3	18.1	15.4	1.28	0.015	104.8	0.073	3.4
5/6/1968	41.3	13.4	11.6	8.4	59.1	10.1	213.3	21.1	11.4	0.15	0.003	337.9	0.01	2.2
7/19/1968	26.3	17.5	8.87	8.15	66.9	11.4	238.5	16.9	7.7	0.05	0.002	346.5	0.024	1.8
9/10/1968	22.5	14.4	9.26	7.95	66.4	15.7	260.5	20.4	8	0.05	0.002	378.9	0.015	2
10/31/1968	33.6	0.4	13.5	7.85	72.3	14.7	275.7	20.7	5.6	0.15	0.003	396.4	0.05	3.6
3/19/1969	19	0	5.65	7.7	83.3	14.6	262.3	24.7	5.1	1.3	0.004	391.3	0.002	5
4/15/1969	616	1.2	11.1	7.7	25.4	4.2	72	17.3	4.6	1.37	0.028	126.9	0.059	3.2
5/15/1969	40.6	14.7	8.63	8.1	59.4	10.8	212.9	14	5.2	0.05	0.002	304.2	0.042	1.6
7/10/1969	29.5	24.8	9.02	8.05	62.7	9.8	205	14.8	5.2	0.05	0.002	301.6	0.032	1.4
9/10/1969	25.8	12.8	10.3	8.05	66.5	8.7	234.8	14.8	5.6	0.1	0.002	337.5	0.259	2.4
12/11/1969	148	0.1	13	7.9	46.7	9.1	153.7	21	5.3	1.18	0.019	238.2	0.05	4.2
1/10/2001	82.2	1	9.7	7.48	69.7	10.2	259	7.7	10.1	0.42	0.021	368.6	0.039	4.3
3/17/2001	151	1.8	9.97	7.73	40.1	10.2	168	13.4	11	0.22	0.058	256.9	0.043	5.3
4/9/2001	1200	2.7	10.62	7.41	22.4	3.4	79	12.5	5	0.18	0.028	131	0.088	5
4/17/2001	396	3.9	10.29	7.75	28.1	6.8	113	7.7	4.3	0.19	0.02	165.3	0.061	4.5
7/4/2001	50.5	22.4	11.46	7.48	69.7	14.1	264	23.1	11	0.18	0.018	394.8	0.031	3.2
9/5/2001	41	14.2	8.98	7.4	72.1	13.6	284	19.2	9.9	0.19	0.019	415.2	0.017	3
11/2/2001	47.2	5.4	7.83	7.45	80.2	13.6	308	11.5	13.5	0.31	0.018	442.5	0.024	7.7
1/10/2002	40.8	0.2	8.33	7.38	71.3	5.4	238	25.9	10.6	0.24	0.023	371.2	0.064	6.1
3/1/2002	116	0.2	7.52	7.28	41.7	11.7	162	20.2	9.2	0.4	0.032	254.7	0.078	5
3/10/2002	437	1.4	8.82	7.25	40.1	8.8	153	14.4	7.8	0.3	0.066	233.9	0.067	5.7
3/20/2002	243	1.6	8.99	7.65	41.7	8.8	159	18.3	8.5	0.33	0.035	248.9	0.05	3
5/7/2002	57	11.5	9.48	7.34	55.3	10.2	214	14.4	9.2	0.27	0.016	316.4	0.045	2
7/10/2002	25.3	23	9.15	7.42	68.1	14.6	275	21.2	11.3	0.26	0.023	408.3	0.044	4.9
9/10/2002	27.8	15.9	9.13	7.2	71.3	14.1	281	21.1	14.9	0.17	0.014	422	0.042	1.6
11/11/2002	35.1	2.5	8.01	7.35	74.5	4.4	244	17.3	9.6	0.2	0.021	365.1	0.03	5.3
1/13/2003	24.5	0.5	9.15	7.37	70.5	12.6	272	19.8	6.4	0.19	0.011	394.5	0.028	5
4/10/2003	235	0.8	9.79	7.53	60.1	4.9	201	19.2	10.6	0.36	0.028	313.3	0.075	4.9

4/20/2003	601	5.7	8.99	7.52	28.1	5.4	107	7.7	2.8	0.54	0.054	158.4	0.085	5.3
4/22/2003	52.7	6.4	8.99	7.48	34.5	5.4	128	13.4	6.4	0.45	0.048	200.6	0.061	2.9
7/7/2003	35.4	17.2	8.8	7.44	81.8	2.2	253	15.4	9.6	0.25	0.021	375.7	0.038	3.2
9/3/2003	75.2	14.1	10.12	7.48	64.1	9.7	238	15.4	9.9	0.24	0.02	351.2	0.036	3
11/3/2003	50.5	2.2	10.46	7.4	72.1	7.3	250	18.3	10.6	0.21	0.023	374.3	0.036	5.3
3/2/2004	55.7	0.4	8.1	7.38	80.2	7.1	275	20.7	10.6	0.32	0.007	395	0.044	5.2
3/25/2004	563	2.8	9.48	7.68	63.3	5.4	214	25	11.3	0.17	0.009	338.6	0.019	4.7
3/29/2004	1310	3.4	9.52	7.8	20	6.3	88	9.6	4.3	0.47	0.072	137.8	0.057	4.6
4/8/2004	170	5	10.12	7.55	32.5	4.6	116	14.4	7.1	0.39	0.058	187.3	0.076	4.2
7/13/2004	95.8	18.6	10.11	7.59	74.1	6.6	232	18.3	15	0.2	0.019	356.5	0.037	3.1
9/16/2004	39.3	12.8	10.75	7.64	64.9	6.32	223	16.8	10.6	0.18	0.012	336.3	0.035	3
11/10/2004	58.2	3.8	9.01	7.38	61.7	10.2	235	13.9	10.6	0.23	0.017	346	0.1	5.2
2/11/2005	72	0.2	9.1	7.4	80.2	4.4	275	14.9	8.5	0.25	0.009	401.9	0.042	5.1
3/28/2005	46.2	0.9	9.31	7.5	64.9	21.4	299	15.4	10.3	0.3	0.005	425.6	0.023	4.7
4/7/2005	67.9	1.4	9.24	7.7	50	7.8	183	23.1	11.3	0.24	0.029	293.9	0.053	6
4/12/2005	1230	3	9.4	7.77	24.1	7.3	104	8.6	9.2	0.34	0.012	163.7	0.045	5
5/5/2005	109	10	9.36	7.79	52.1	9.7	201	11.5	12.4	0.3	0.022	300.5	0.038	4.3
7/12/2005	50.8	20.8	9.83	7.67	66.5	11.7	256	15.4	7.1	0.17	0.013	368.8	0.015	3.8
9/13/2005	49.2	15.3	11.02	7.5	65.3	9	241	13.4	9.6	0.24	0.015	352.4	0.041	3.9
11/11/2005	43.4	4.5	9.81	7.87	76.2	14.6	296	19.2	13.5	0.3	0.014	437.2	0.02	3.7
2/14/2006	35.6	0.6	8	7.55	76.2	10.2	278	28.3	14.5	0.18	0.014	431	0.025	4.8
3/13/2006	44.7	0.9	8.11	7.61	72.1	10.3	262	24	14.2	0.27	0.018	403.2	0.035	4.4
4/5/2006	59.8	1	9.46	7.59	85	14.1	323	28.8	10.6	0.23	0.008	483	0.01	5.8
4/16/2006	1210	4.6	9.54	7.73	16	3.3	61	13.4	7.1	0.25	0.058	112.9	0.058	5.5
5/24/2006	230	8.2	9.52	7.51	22	7.3	98	15.4	9.2	0.25	0.036	165.6	0.04	3.5
7/3/2006	49.4	19	11.07	7.32	62.9	5.6	211	13.4	12.1	0.28	0.014	318.6	0.048	2.9
9/13/2006	195	14.5	11.15	7.42	46.5	10.7	189	15.4	14.5	0.16	0.012	292.8	0.063	2.6
11/13/2006	127	1	10.1	7.99	64.1	13.1	256	7.2	10.6	0.21	0.013	361.8	0.035	4.9
2/12/2007	87	0.7	7.86	7.33	71.3	12.2	275	12.5	10.6	0.28	0.017	395.9	0.048	3.3
3/6/2007	82.4	0.4	8.5	7.6	68.1	7.3	238	13.4	13.5	0.25	0.018	356	0.04	3
3/20/2007	950	2	9.45	7.6	18.4	5.8	76	6.7	3.5	0.43	0.03	115.4	0.085	4.8
7/12/2007	43.3	20.2	11.76	7.45	69.7	18.5	296	26.9	10.6	0.18	0.018	440.6	0.01	2.7
4/5/2007	92.1	8	9.52	7.62	36.9	3.2	122	10.1	4.6	0.26	0.025	184.5	0.065	3.6
9/13/2007	44.2	13.2	9.97	7.48	69.7	10.5	259	14.4	10.3	0.25	0.018	378.1	0.035	2.5
11/15/2007	48.7	0.4	9.3	7.9	64.1	11.7	250	18.3	12.1	0.38	0.017	375.2	0.058	2.7

Дата			pH	Ca	Mg	HCO3	SO4	Cl	сумма	Ж общ
I	Январь	ср.знач.	7.3525	78.18333	11.56667	271.2167	23.88333	7.65	401.95	4.87
II	Февраль	ср.знач.	7.355	72.27143	10.74286	266.8286	15.98571	7.528571	385.6	4.495714
III	Март	ср.знач.	7.430909	56.8125	10.52083	206.7208	19.86667	7.154167	312.5439	3.665
IV	Апрель	ср.знач.	7.370313	24.41667	4.492857	81.29048	14.47381	4.261905	134.4317	1.615122
V	Май	ср.знач.	7.659231	48.52857	8.778571	174.2571	19.14286	5.814286	263.6214	3.227857
VI	Июнь	ср.знач.	7.91	57.85	10.85	217.15	15.48333	3.866667	301.34	3.773333
VII	Июль	ср.знач.	7.60125	64.41111	11.15	232.8778	19.16667	7.35	343.4444	4.14
VIII	Август	ср.знач.	7.6875	61.16	12.88	234.42	22.04	4.58	343.22	5.582
IX	Сентябрь	ср.знач.	7.59	67.35333	11.668	246.84	24.1	8.4	374.6071	4.318571
X	Октябрь	ср.знач.	7.521429	64.3	13.98571	234.6571	29.35714	5.514286	342.3429	4.378571
XI	Ноябрь	ср.знач.	7.569412	74.63158	12.73158	261.6053	21.98947	7.905263	387.5368	5.203684
XII	Декабрь	ср.знач.	7.3375	63.41818	10.83636	223.8	20.9	5.054545	329.8909	4.07