APPENDIX F-9
Manual for the Construction and Use of Watershed Models

Jason Lasuik

Introduction

History

This Manual is based in part on the "Watershed Model Construction Manual" produced by the Canadian "Stream Team"[1] Society, a non-profit group that was inspired and created by Mr. Angus Stewart, a teacher and environmentalist who lives and works in Victoria, Canada. This group recognized that "as increased urbanization threatens more local watersheds, a holistic approach to watershed management and conservations is required. The Stream Team recognizes this and promotes the concept that watersheds are diverse, complex natural systems (and that) direct experience in habitat projects enables students to develop their own watershed ethic....Members of the Stream Team volunteer their time to educate, inform and take appropriate actions to protect and restore local aquatic habitats and support the efforts of community-based stewardship organizations. They also volunteer their time to improve their Streamkeepers skills (excerpt from *Watershed Model Construction Manual: A Step by Step Guide*).

This program evolved to include the construction of 3-D models of local micro-basins which are presented to youth as an integrated and hands-on way to learn about watershed concepts. In addition, it helped forge many meaningful partnerships with other community outreach educators. This, in turn, led to working with teachers to begin developing integrated programs that allowed youth to help increase community awareness about local environmental issues. It was in his capacity as Environmental Coordinator for the Burnside-Gorge Community Association, that Mr. Jason Lasuik, became involved in promoting student participation into the final construction phases of watershed models and the promotion of what we will refer to as "Active Change Agents"[2] in the classroom setting. These young ambassadors help develop meaningful links between classroom learning and active community involvement in important environmental issues.

A similar desire to create positive changes that lead towards a healthier environment was resoundingly voiced during the reconnaissance tour of a WFT team that was developing a strategy for the environmental education component of Project *Peixes, Pessoas e Água* (see Carolsfeld and Johnsen 2006. One of

[1] The Stream Team is a group of responsible, trained secondary and post-secondary students who promote awareness and stewardship of local watersheds. Team members are certified Streamkeepers through the Fisheries and Oceans Canada Program.
[2] A person who is actively involved in community activities that promote increased environmental awareness and improving the health of the local &;or global environment.

the main recommendations that emerged was to use watershed models of local micro-basins as a focal tool to engage local communities, increase awareness about the health of local watersheds and provide a spring board for the development of community driven environmental initiatives in the project area. It was within this context that Mr. Jason Lasuik was hired to engage the communities of Três Marias and Beira Rio in the construction of a watershed model for the Córrego Barreiro Grande.

For the first time, this was to be carried out with the full and long term participation and commitment of community members, starting from the planning and early construction phase through to the development of public presentations that use the model as an interactive tool to increase community awareness about local environmental issues. In this way, we hoped that the models would become an even more powerful learning tool and succeed even more fully in engaging the local community in creating initiatives that would address local environmental concerns in a sustainable fashion.

Purpose of this Manual

The purpose of this manual is to provide any community, in Brazil or any part of the world, with the tools it needs to take charge of developing participatory educational experiences that use a watershed model as its focal tool.

This first edition is based on the Brazilian-Canadian experience in Brazil. It is intended to be a work in progress that evolves on an ongoing basis as new participants come on board and their experiences are incorporated into it. In time, we hope that some of the concepts and lessons learned from the Brazilian experience will also contribute back to the continued evolution of Canadian and other international programs involving watershed education.

The manual involves aspects of both the construction of the model and guidelines to assist new participants in using it effectively in their community, including:

1. a step-by-step guide to the process involved in building your own watershed model, which can be applied to any micro-basin, anywhere;
2. background information to help anyone understand more about their own watershed, the hydrological processes that are happening in it and the effects that activities in your community (and even in your own home) can have on that watershed; and
3. guidelines to help teachers and community educators use the model as a focal tool for environmental education programs that meet local community needs; and
4. providing the framework to support an active network of environmental educators within and between communities.

The Challenge

Developing the impetus to foster changes in attitude that will ultimately lead to a healthier environment is difficult to achieve and slow to evolve to a self-sustaining level. Success depends on both having the appropriate materials or tools available and an element of human involvement, both of which need to appeal to different belief systems and learning styles in order to be effective. However, the key objective is always to create interest in the environment, develop tools that promote opportunities for environmental education experiences within the local community and to increase environmental awareness amongst all participants.

When these objectives are met, a vehicle for developing a team of "Active Change Agents"[2] is set in motion, thus paving the way for positive, long term changes in the way communities interact with each other and their environment. The watershed model and the participative method of its construction and presentation has been shown to be such a tool. It provides rich and meaningful opportunities for communities to recognize and address their specific environmental concerns within the context of both their particular socio-economic needs and global environmental issues.

It also provides guidelines and ideas for engaging local residents in all phases of planning, building and using the watershed model as a focal tool that ensures that these experiences are meaningful and will lead to long term and active commitment. The model does much more than simply improve knowledge and understanding of the issues: it demonstrates the significant cumulative impact that individual actions can have on the overall health of a watershed, and provides a mechanism for developing local teams of self-directed and Active Change Agents. These are the key participants who will take the model to new levels and develop their own presentations and activities to engage their community and make meaningful changes

Background information

What is a Watershed

We all live within a watershed. A watershed is defined by hills that dictate where the water will flow. A working watershed model will replicate a local watershed in your community. The 3-D model represents the local terrain, vegetation, water features, urban landmarks, and associated pollution concerns. Following the

[2] A person who is actively involved in community activities that promote increased environmental awareness and improving the health of the local &;or global environment.

route water takes to eventually enter into a receiving environment it can include the local: lakes, streams, wetlands, estuaries, or inlets.

As an interactive 'pour and play' tool, a fun atmosphere is created when water is poured on to the model and mixed with representative pollution. Students learn how they contribute to water quality problems and how they can be part of the solution. It promotes exploration and observations of how environmental and human features interact. This essentially includes the basic geography, biology and hydrology features of your neighbourhood. When the rain is simulated and the water is added to the model it will run from the highland to the lowlands. As the water flows on the model it picks up the representative pollution, and changes colour, creating a visual learning experience. An increase knowledge and literacy of the environment occurs with presentations and discussions of the problems and solutions in a fun atmosphere.

The process of building a watershed model can provide students and teachers alike with opportunities to directly participate in local restoration and protection projects, and support stewardship efforts in schools and on school property.

How to use the Manual

This manual is intended to be a guide for the construction and presentation of a local watershed in you area. The construction of a model is a great way to get students in touch with their local area, and kids involved in the construction process become naturals to do the presentations once it is complete!

This manual will take you through the steps of constructing your own watershed model, and create a meaningful watershed experience. A meaningful experience involves field investigations, classroom based research, and student action designed to reduce pollution, improve water quality and understand what makes-up a watershed. The essential steps include planning, constructing, and implementation with presentations. Each step supports another and involves participation from the student and community. Teachers are not expected to know it all, and are encouraged to work with the students in problem solving and discussions during every stage.

Planning

Some familiarity and background of your local area will help in planning for the watershed model. There are some essential steps that will greatly assist in the construction process.

1. *Identify the local area that is suitable to model.*

The area your model represents should contain a waterway such as local: lakes, streams, wetlands, estuaries, or inlets. Some questions to ask include:

- What is the main waterway in which the stream enters?
- Are there obvious pollution problems that can be easily identified by students or community members?

It is best to identify the options available to you. You may want to do a model that is based on a smaller area (micro-scale) or larger area (macro-scale). A micro scale model can focuses on one, two, or three streams and the surrounding environment. A macro-scale model encompasses a larger area, which may include several streams entering a larger waterway. A micro-scale model can be more personnel while macro scale is a more encompassing representation of the area. It is best to identify the options available to you. Having options will allow you to be better prepared for particular restrictions regarding resources available.

2. Identify the watershed characteristics

There are several characteristics of the watershed that are especially valuable ecologically, economically or socially. These may be natural or urban features that help give the watershed a sense of identity. For example, they may include landscape traits that symbolize the watershed, such as forests, or mixed farmland and urban development. Initially you do not need to address all the concerns because this is ongoing learning process. Many features will reveal themselves during the construction and associated activities with the students. It is helpful to complete a quick tour of the watershed area and pay attention to the terrain.

3. Discover the level of support

Seek out other people who may be interested and make a list of those who may be able to assist by providing material and resources. Your class can take the lead on the construction process and it can easily become a focal point for many classroom activities. It is recommended for you to let the school administration know so they can help create an atmosphere of partnership and enthusiasm. You may want to present the idea at community and staff meetings. For a more enriching experience there can be many key participants, which may include:

- Parents, caregivers and family members

You can actively recruit volunteers and encourage parent participation. Remember this program proposes the implementation of variety of activities regarding the health of the community environment; it's not just gluing together a model. If individuals are resistant, listen carefully. You may not have all the answers, but be willing to acknowledge people's questions and concerns.

- Students

Ask student groups such as environmental groups or student council for ideas and suggestions. This may be a good opportunity to start an environmental club if there isn't one! Include them in the planning activities so they are empowered by there decisions and feel some ownership. To encourage student a broader school interest and motivation, promote the watershed model as a fun, challenging and look for opportunities for them to observe activities that improve the health of the waterway.

- Teachers

Staff members should be actively included in your planning decisions and kept informed. You may want to team up with a couple of other classes in the building of the watershed model. Teacher support is important because they are a direct link to the students and may be useful allies in informing children and parents about the program. Teachers are role models and influence children attitudes and behaviours. They can incorporate watershed education in their classroom and address related issues during class discussions.

- School Neighbourhood Community

A caring responsible community near the school is important for improving the health of the neighbourhood and enriching the learning experience. To gain community support, inform the neighbourhood of how the possible educational experiences and how a watershed model will represent the community. Neighbourhood associations can be a helpful resource by providing volunteers, materials and space.

- City and Government officials

City or town councillors can become champions for your efforts and help connect you to municipal employees who will assist you with planning, materials and transportation. They may be big help in providing enlarged maps or required funding.

- Local or State Businesses

Often many local businesses are willing to provide support for good will activities that are recognised to improve the environment. It is always worth approaching businesses for items such as maps, transportation or a donation of materials. Sometimes it is just a matter of informing them of the upcoming educational experience.

4. *Gather various maps of the area.*

The more maps the better informed you will be. There are various types of maps produced for your local area, which can include road city or trail maps. Maps ostensibly classify and synthesized information to assist in communicating or transferring information. In the planning stages this will assist in better understanding the local features and can also be displayed during the construction phase. Coloured aerial photographs are a great asset and these can sometimes be available through local government or industries.

To model the surrounding area you will need a topographical map with contour lines. The contour interval is the vertical distance between successive contours and is consistent throughout a topographical map. By showing changes in elevation throughout the map, contours make it possible to describe the terrain. As you work through the construction phase contour patterns will morph into hills and valleys found within your neighbourhood.

The smaller the map scale, generally the larger the contour interval and more detailed the information, although the contour intervals can be the same for different maps. For example, the contour interval for maps at a scale of 1:50,000 are generally 20 meters. Finding different maps containing various contour intervals is useful for when you decide what contour interval is best for your model. The ultimate map that you will use should be clear and easy to read with water features, land use features, and main roads.

5. *Discover the change in elevation*

On the topographical map identify the change in elevation. Locate the points of highest elevation and difference in height from the waterway to the top of the hill. It is ideal to have the highpoints at the periphery of the model so water will not pool along the edges. Locating the high point will indicate the watershed model boundaries and assist in deciding area that is capable of being modelled and whether it is feasible to do a micro or macro scale model.

6. Choose the contour interval

The area the model will represent will depend on what is reasonable given the variance in height of the land. The contours we use can vary and you may chose to use every 10m, 20m, 50m, or 100m. The watershed model is meant to be an accurate depiction on the terrain not necessarily is exact. Usually the greater the gain in elevation within the watershed the larger the contour distances chosen. It's recommended to have at least four contour intervals represented on the model and this can vary greatly depending on the terrain. A few key points to consider are:

- In deciding on the contour interval you should consider that the more intervals you use the more work will be required as your students build the layers to form the hills.

- The width of the Styrofoam layers will be consistent with the scale of contours. For example 1cm thick Styrofoam can equal a contour interval of 20m, 40m or 50m. It is meant to remain consist throughout the construction to provide for an accurate depiction of the local terrain.

- The contour level will also determine how thick the Styrofoam will. This will in turn determine the height of the wood sides to be placed on the model and affect the overall weight of the model. Generally you should strive to keep this under 8cm.

7. Decide on the size of the model

The size of the model is dependent on the intended use and ability to enlarge or obtain maps to fit the actual size of the model. Considerations for the ease of transportation should be weighted against the number of students able to gather around the model.

8. Have space available

Your students will need adequate space to work in. At times the space can get messy when dealing with paint and small pieces of Styrofoam. A roof overhead and protection from rain and potential wind gusts that can blow particles around is necessary. You will also need access to electricity in a room that is well ventilated.

9. Produce the maps

- There may be resources available that have a plotter (large printer) that can produce the contour maps for you. This is a great resource because you may be able to receive a map that is tailored to your needs and contains only the information you require. A GIS technician can typically do this and are sometime available through contacting city and government officials or local and state businesses. If so request for features prominent to your local area such as: water features, main roads, parks, and land use features. Depending on the size of the model and printer the maps may come as tiles, in which they need to be taped together.

- If these resources are not available then you can enlarge the topographical map by using a photocopier or photocopy service. It is recommended that the scale of the watershed model be around 1:10,000 to 1:20,000. This allows for a good representation on the local terrain, waterways and 3-D landmark features. If your map scale is 1:50,000 then you should likely enlarge the watershed area so it is 5 xs larger (50,000/10,000). This is taken into consideration with the scale of the map, size of the watershed model and the area of the watershed to model (micro or macro).

    - When enlarging the map by photocopy ensure a small area outside the watershed boundary is included. This will provide for a bit of a buffer.

    - Each separate tile (enlarged photocopy) will then be taped together to form the large working map with contours that are ready to be traced

A. Construction

Materials

6 mm plywood sheet
2cm x 5cm lumber (4 - 185cm, 4 - 125cm or 9 - 43 cm)
Wood Glue
Nails
Screws
Aluminum Flashing

Tools

Hand Saw
Saber saw, Circular Saw or Table Saw
Hammer
Screwdriver
Wood Glue
Measuring tape
Pencil

1. Frame

The first stage in construction of a watershed model is to build a frame or base. You need a simple, light and strong frame that will make the transporting and setting up of the model easy. The base consists of plywood top fastened to a frame consisting of braces that provide reinforcement. The size of the frame may vary and is determined by the size of the watershed model. The measurement provided is for a watershed model that measures 183 cm long x 122 cm wide (6 feet x 4 feet).

The frame consists of a 6mm plywood sheet that is braced by 2cm x 5 cm lumber that is cut and fit to the proper size.

Plywood

The first step is to cut and measure the plywood to the size of the watershed model.

- Measure the length of the board to be 183 cm and mark the distance at each edge and the middle of the plywood sheet.
- Using a straight edge connect the marks by drawing a line across the width of the plywood to indicate the desired length.
- Do the same for the width by measuring 123 cm and marking the width by drawing a straight line across the width of the plywood sheet.

Using a saw, cut along the straight edges to obtain plywood sheet that is 183 cm long x 122 cm wide.

Bracing

a) Purchase wood and have it pre-cut and planed into 2cm x 5cm pieces. You may request to have the pieces cut slightly longer than the desired measure. This will allow for some room with possible errors and misjudgments of the required length due to warping of the wood. If this is a concern, have four (4) pieces that are 185 cm, and five (5) pieces that are 125 cm in length.

- Cut each piece to fit the width of the model. Place two of the 125 cm pieces at each end, along the width of the model.
- Place each piece along the 2cm edge and line up with the edge of the plywood so it is flush along the edge of the plywood. Using a carpenter square, ensure each end has a straight cut.

b) The four 185 cm pieces will be cut to fit inside the braces placed along the width of the plywood sheet. Therefore they will be approximately (183 cm – 2cm) 181 cm. Again, because the wood may be slightly warped the first cut of these piece should be slightly, longer and then trimmed at each end to ensure there is a snug fit.

- Line up the 2 cm x 5cm pieces along the boarder of the plywood so it makes a frame around the plywood sheet. At each end of the model square one of the corners mark a line to indicate the excess length and cut to remove the excess wood.

- Glue together the corners and then hammer a nail into each corner of the frame to hold it together. Be sure to place the nail in a location that will provide space to thread a screw into the wood for better fastening.

- Cut the other two 183 cm pieces to fit snug along the length of the model. Remember the wood may be slightly warped, so the measurements may not be exact (approximately 181 cm).

- Place theses pieces within the frame, along the length of the model at an even distance of 40 cm (122cm/3 =40.6cm -.5cm = ~40cm) from each corner.

- Nail these pieced into place then pre-drill holes and insert 8 screws to fasten each piece in place.

c) Next use the remaining wood to brace the pieces running the length of the model. Cut he three pieces approximately 40cm in length so they fit snug within the center. Remember the wood may be slightly warped and to ensure a snug fit it is recommended to cut them slightly longer and then trim to fit.

- The three braces in the center of the two 181cm pieces should be equally spaced about 45cm, to allow for proper reinforcement.

- Once in place, glue the ends and fasten with screws.

- For the outer braces slightly offset the six other 40cm braces (the dimension may change slightly as the wood is fastened), and allow for room to fasten screws without scraping your knuckles.

- Then glue the edges and fasten with screws.

- With the frame on top of the plywood sheet ensure that it is square and flush on three sides.

- Trace entire frame onto plywood (inside & out) and mark a line where plywood will be trimmed.

- Cut plywood with a saber saw, circular saw or table saw.
- Run a bead of glue along the top of all pieces of the frame, and then place the plywood on TOP of the frame and center it, flush all around. The outline you traced earlier will show you where to screw through the plywood into the frame, and will save you guessing.

- Using a cordless screwdriver or drill with a driver attachment, start screwing in one corner, and work your way towards the opposite corner. It is not necessary to pre-drill these screws, Make sure the screws are flush or slightly recessed below the plane of the plywood.

Aluminum Flashing

To prevent water from seeping into the wood and potentially rotting it add protection in the location where water will eventually run-off. This may be done using aluminum flashing.

- Place the map on the model and determine the area that water will flow off the model and place at least a 31cm of aluminum flashing over the area.

- Glue and clamp flashing to the top of the plywood Make sure the flashing wraps all the way around the bottom of the frame and attach screws to the underside.

2. Styrofoam Base

Materials

Three (3), 2m x 1m Styrofoam that are 15mm in thickness
Three (3), 2m x 1m Styrofoam that are 30mm in thickness
1 kg of Cascorez extra glue.
Sharp Utility Knife
Several weights that will assist distributing the weight and not indent the Styrofoam.

Tools

Construction Glue
Large putty knife

- Place the frame on the floor and place 500g of adhesive to the plywood.
- Quickly use a large putty knife or similar flat metal device to spread the adhesive. It is especially important to cover the flashing fully and ensure the glue covers the entire edge on each side of the model.

- Place three of the 15mm sheets of Styrofoam onto the glued plywood. Center the three pieces and place glue along the edges that are to be attached.

- Trim excess with a sharp utility knife.

- Place the entire model upside down on a clean level floor.

- Put as much weight onto the frame as you can, making sure that it's evenly distributed over the entire frame. Cinder blocks work well. Leave for at least 24 hours.

Next Day

- Where necessary fill the seams of the Styrofoam and let it dry for several hours.
- Repeat the process by with placing the three of the 30mm sheets of Styrofoam onto the15mm sheets.

The two layers of Styrofoam act as the base. You will not carve into the bottom 15mm sheet. The 30 mm Styrofoam is likely where you will carve the waterway. Depending on how deep you need the waterway to be (think of how the water will flow) you may add an additional layer of Styrofoam by gluing it on top.

B. Creating the Topography and Water Features

Materials

Contour Map sized to watershed model
Glue
Plastic tubing
Plaster

Tools

Pencil
Utility Knife
Sand Paper 100 and 280 grit
Car Body File (bondo File)
Palm Sander

Using the elevation change and contour intervals you chose in step 5 and 6 of the planning stage you are ready to begin tracing the contours. The first contour level can be traced onto the base layer.

- Lay the map on top of the Styrofoam. Line up the waterway (drainage area) with the flashing or plastic. Pin it securely in place and mark the corners on the map, and base layer to assist with proper positioning for upcoming contour levels.

- Using a sharp pencil, lightly poke through the map into the Styrofoam. Do this in dots following the shoreline to indicate the waterway, streams and first contour lines. Remove the map and using a dull pencil connect the dots to indicate where the next Styrofoam piece will be placed. .

- Secure the topographical map on a piece of Styrofoam. If your contour interval is essentially one large area covering a large surface of the watershed model, you will need to tape together enough Styrofoam to reproduce the entire contour.

- Use a sharp pencil to poke through to mark the outer edge of contour line one and contour line two. Contour line two will provide guidance for placement of the next contour level. Remove the map and join the dots.

Using the file, sand paper, or sharp knife create a slope from the bottom (contour one) to contour two.

- Creating a proper slope at the edge of the Styrofoam by shaving it with a bondo (car body) file or knife at an angle that best represents the slope.

- Use the next contour lines traced onto the Styrofoam as a guide, and leave this area flat to allow for placement of the next contour. Then sand the entire edge with the 100 grit, then 280 grit sandpaper to create a smooth gradual slope.

- Place the Styrofoam on the base layer and line it up with contour lines traced onto the base payer. Let the Styrofoam hang over the edge about 2 cm and carefully remove any excess Styrofoam.

- Due this for the remaining contours you chose in the planning stage, until you are finished building your local terrain.

Tip: As you are creating your high and low spots, always picture water falling on the surface, and make sure that the water will flow where it is supposed to! Avoid creating wells where the water will get trapped.

Tip: Sand lightly and in one direction. The Styrofoam can sometime rip or tear while sanding, leaving an unwanted depression. If this occurs smooth the surface, fill with plaster, let it dry and sand the excess to make a smooth surface.

- Once all elevation pieces are cut and sanded carefully line them up and use panel adhesive to glue them together. Do not glue to the base yet.

<u>Form the waterway</u>

While the glue is drying you can form your waterway into the top base layer. This can be sanded down to the 15mm Styrofoam at the area where the water will discharge. *Remember do not carve into the underlying 15mm Styrofoam! You need this as a layer of protection for the underlying wood.*

- Start with the shoreline. Make the waterway with a gradual slope to permit water to flow to the exit off of the table. You may get creative and imitate falls or high flow areas by changing the depth or width of the waterway in particular sections.

  - Using a knife: Carve along the periphery of the shoreline, and then cut out individual sections of the foam until the entire waterway is done. Sand the surface to make it smooth.

  - Using a palm Sander: Sand away portion of the base layer to create the beach and drainage area.

  - Using a rotary sanding tool: Set the device to the desired depth. Start at the edge and carve the shape of the waterway into the Styrofoam. Due this for the entire waterway, then sand the surface so it is smooth.

Create the Streams

Place the glued topography on the watershed table so it lines up with the contour lines traced on the base. Position the map on top of the topography and line up the corners as best as possible. Trace the streams in the same method as the contour lines. It is recommended to trace the streambed wider than the scale to improve water flow.

- Using a Utility Knife creating a trough by carefully carving out the streambed along the traced lines. Do this at a depth that will allow the water to flow properly. Do not initially cut too deep as, you can always make it deeper by sanding.

- In places where there are large bends and steeper slopes you may exaggerate the streambed further to improve the water flow.

- If there is a lake you may want to have a slight depression to gather some water and indicate this.

Sand the streambed

Create a smooth and continuous streambed by sanding the entire length with 280 grit sandpaper.

Tip: The edge of a 15mm Styrofoam usually works well for sanding the streambeds. As well sanding can greatly enhance the depth of the stream. Create your own tool by molding and sanding a thin piece of Styrofoam and

wrapping a piece of 100 grit sandpaper around it. Use the edge to mold and smoothen the streambed.

Insert sewers.

To represent storm drains or sewers you can hide plastic tubing in the base layer of Styrofoam. Determine the location on the base Styrofoam –we recommend the entire length of the tubing to remain accessible and not be covered by any other topography.

- Carve a trough, just as you did with the streambed.
- Put glue and a small line of silicone along the bottom and sides of the trough. Measure, cut and plug each end of the hose with tissue.
- Place the hosing deep enough in the trough, so you can cover it with a thin layer(s) of foam that are the same size and shape of each stretch that represent sewers. One end of the hose will discharge into the streambed while the other will remain open to allow water to flow into the tube.
- Sand the Styrofoam with 280-grti paper to make an even surface with the base.

Glue the topography onto the base.

Use an ample amount of glue and spread it evenly on the base to ensure the edges will adhere to the base. Let it properly dry.

Smoothen the topography.

Using the 280-grit sandpaper sand the joining contours to have them blend together.

For further protection and place plaster the entire model. This will to protect it from being damaged from the varnish, and allow more continuity between the contours.

- Using your hands ensure to cover the entire surface. The smoother the plaster the less sanding you will have to do.
- Let it dry for about 12 hours.
- Sand the entire surface with 280-grit sandpaper.

C. Paint the model

Materials

Paint
Paintbrushes
Masking Tape
Varnish

Once hills, valleys and streams have all been given a final sand you are ready to paint the model. **MAKE SURE TO USE A LATEX 0R ACRYLIC-BASED PAINT!** Oil-based paint will melt your Styrofoam!

You should use several different colours to make the model as colorful as possible. You can use water ever colours you like. We suggest some of the following colors for representation of the water and land:

- a very light blue for the ocean and streams (light blue, will contrasts well with contaminants)
- a red, orange, and white and various combinations of these colours to imitate the colour of the landscape
- a sandy colour for () marshes and wetlands
- a few different shades of green
- a gray and black for the pavement.

- Paint the waterways first.

- Then paint a base coat (various combinations of the red, orange and white) to represent the landscape.

Tip: Use different techniques, such as dapping the brush to combine various colours for the landscape

- Let the paint dry for 24 hours.

- Give the waterways and any other area necessary a second coat of pain.

- Let dry for another 24 hours

Paint the Roads and determine the boundaries

- Place the map on top of the model and align the topography with the contours.

- Determine the width of the roads and use a thin-width masking tap to indicate where the major roads are. Be weary of doing too many roads as this may cause much confusion.

- Very lightly trace the roads with a pencil.

- Remove the tape and paint with gray or black.

- You may sand particular sections of the road to indicate how the landscape was leveled for the construction of the road. If you do this remember to use plaster to smoothen and protect the surface and give it time to dry before painting.

- Use the map aligned properly on the model for determination of any other landscape features people will identify with. You may due this for any other landscape features i.e. parking lots, airports, holding ponds, etc.
- Paint the areas an assigned colour. For vegetative areas, such as along the streams, use various colours of green and lightly dap the area to give it a layer of green.

- Continue this process of layering the colours to assist in distinguishing the landscape.

Waterproofing

Ensure the entire model is dry.

- Using a brush place several (4) coats of varnish on the model. Be sure to allow the varnish to dry between coats.

- Be careful of Varnish coming in contact with the Styrofoam and not place varnish on the exposed edges and the area around the tubing. You may choose to place a temporary coat of plaster on the edge of the model to protect it.

D. Put on the sides

Materials

Plywood Sheet (about 15mm in thickness)
Measuring Tape
Glue
Screws
Nails

Tools

Screwdriver
Saw
Hammer

This is going to add the majority of the weight to the model. Therefore you want to add wood that is strong but light. Previously we have used 15 mm Naval Plywood.

- Using a saw and sand paper trim the sides of the Styrofoam to create a flat and even surface. It important to have a tight fit and no gaps between the sides and the Styrofoam.

- Measure and cut sides allowing at least 4cm clearance above the highest hill. This will allow room for placement of landmark featured.

- Join the corners by making a rabbet joint by sawing halfway through the ends of the pieces running along the width of the model. Make sure the dimensions from the exterior boarder and interior boarder are the same dimensions as the wood thickness. Mark the dimension of the wood by placing the sidepiece against the end where it will join. The pieces running along the width will be on the outside. Mark the width of the wood along the edges you will join. Saw halfway through the end pieces.

- On the side where the flashing is (drainage area) measure the drainage area on the wood side and remove the wood. **Be sure it overlaps the flashing!** You can draw a semi-circle on the bottom portion of the wood that measures a width slightly less than the width of the drainage area. A small can be used to trace the curve.

- Lightly sand the top edges of the sides to smooth them and apply at least 2 layers of the same varnish you used to seal the model. Allow the coats to dry overnight before re-applying.

- Line up the sides on the outside of the frame. Make sure that the Styrofoam edges of the model are flush with the frame.

- Place sides against frame and hold them in place.

- Pre-drill holes and screw sides to frame using raised washers (finishing washers).

- Run a generous bead of silicone caulking around the inside edge of the model, between the Styrofoam and the sides. This prevents the water from running down between the layers.

E. Build a lid

Materials

Excess 15mm plywood
.6mm plywood
Measuring Tape
Glue
Nails
Varnish

Tools
Saw
Hammer
Measuring tape

Use the excess wood from the side for the model for the sides of the lid. Cut the strips about 8cm in width and allow for the excess length that matches the width of the wood.

- Using the 15mm naval wood extend each piece 30mm in length. Use the same method to join the corners.
- Using a hammer, partially nail the pieces onto the side of the model to hold them in place.
- Then glue and screw the corners to fasten the pieces together.
- Next cut the .6mm plywood to fit on top of the sides of the lid.
- Place glue along the entire periphery and nail the plywood onto the supports.
- Remove the lid and varnish both sides.

F. Final Features

This is a very creative and fun stage of the model that can be simultaneously done during any stage of building the watershed model.

Materials

Paint
Paint Brushes
Excess Styrofoam

Esponja
Representative Natural Vegetation
Varnish
Silicone
Sandpaper

Tools

Knife
Scissors
Silicon dispenser

- Using the excess Styrofoam creates landmark features such as houses and representative buildings found in the watershed area. Paint them. The more colour the better.

- Busha can be used to create tree. Paint the *esponja* green and glue onto twigs. To represent different trees various colours can be used. Use a thin piece of Styrofoam that is painted the same colour to match the terrain as a base so it may be glued onto the watershed model. Glue the trees into the Styrofoam.

- Collect natural vegetation to create miniature representative area. To preserve the natural vegetation coat it with varnish and let it dry. As you did with the imitation trees, place the natural vegetation into a Styrofoam base.

- Use a hot glue gun to adhere the vegetation and landmark features onto the model. Place a small amount of silicon around each the base of each feature.

You can place anything onto the model, including small toy cars, boats, wildlife and bridges made of Popsicle sticks.

G. Maintenance

Constructed carefully, with occasional minor maintenance, your watershed model should last for many presentations. You may have to reapply coats of varnish every so often and it is always good to have a glue gun handy at presentations! I highly recommend allowing your model to dry in a warm place with the upstream end propped up. () Leaving your model in the sun for extended periods of time can be very destructive. Try to avoid this.

H. Helpful Hints on Pollutants

You may use foodstuffs that not harmful to the environment and can be disposed of safely after the presentations. For example:

- **Juice crystals** for pesticides and herbicides and fertilizers
- **Soy Sauce** for motor oil. ()
- **Green food colouring** in water also makes a convincing anti-freeze.
- **Tiny bit of Styrofoam to represent garbage.**

Use a plastic bin to collect the water from the model…. this is your ocean or main river, and when full of foodstuffs looks pretty convincingly polluted!

I. Testing

Make sure to test your model before the big unveiling! A number of test runs complete with water, foodstuffs and a prepared talk will help to iron out any wrinkles and catch any minor problems before you're doing public presentations. You will also want to experiment with different support structures for your model. It will be important that your model is set up with just the right slope to it. If it's too flat your rivers might back up and if it is too tilted you might have areas flood as rivers run over their banks. This may happen to some degree so experiment with different setups. Use four knockdown sawhorses to support our models and have a little box with different sized shims. Some presentation spots may not be level. Therefore shimming between the supports and the model may be necessary.

J. Presentation

At presentations, people always want to know more about the issues in their watershed after being part of a model demonstration. Historical maps and aerial photographs (good copies of our working maps) are a great complement to the models, and as well, it is a good idea to have good handout information and the contact information for your group handy. You might also want to have the contact information for your support groups and agencies so that you can direct people in their direction!