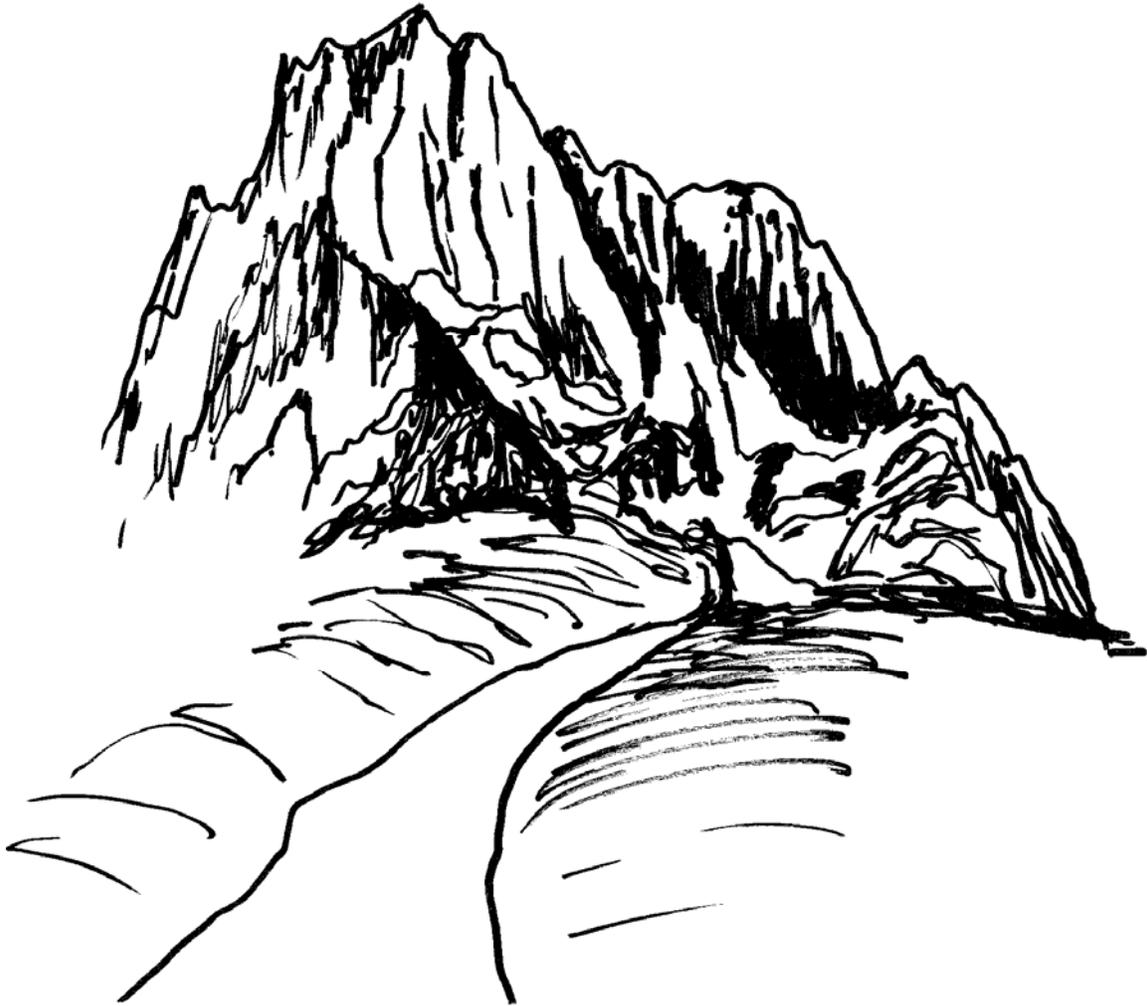


# **Watershed Monitoring and Assessment Design Workbook**

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**By Barb Horn and Geoff Dates**

*Funded by United States Environmental Protection Agency, Region VIII*

**Rocky Mountain Watershed Network**  
**Presents:**  
**WATERSHED MONITORING AND**  
**ASSESSMENT DESIGN WORKBOOK**  
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# PHASE 1: PEOPLE DESIGN: (Build the Foundation)

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**Step 1 - Share Watershed Vision and Desired Outcomes (Results)**

**Step 2 - Scope Inventory (Physical, People, and Information)**

**Step 3 - Identify Monitoring Reason(s) and Data Use(s) (Assessment Type)**

**Step 4 - Develop Monitoring Questions (Refinement of Monitoring Reason)**

**Step 5 - Target Decision Makers and Information Needs (Refinement of Use)**

**Step 6 - Summarize with an Information Blue Print-Data Pathway Fact Sheet**

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## Introduction and Summary of Phase 1

Perhaps the most important step in assessing your watershed is to know and understand **why** you have decided to conduct an assessment. Even if this seems simple, the exploration of why we are monitoring and assessing provides the meat and vegetables for the stew, the foundation for which we design our monitoring activities, analyses, reporting and evaluation. Why do you want to assess the health of your watershed? What exactly will we monitor and assess to determine the condition of our favorite water body? What specifically could we monitor to ensure that the quantity and quality of water in our watershed is sustained? Why is this so important to do? How will you define and communicate the foundation for what you actually do? How will you know if what you do moves you closer to your desired outcomes?

The steps in this Phase are designed to assist in *identifying and building the foundation* for chosen monitoring and assessment activities. The foundation for monitoring and assessment activities is part desired outcomes/results and part people orientation. Identifying the desired outcomes or results of monitoring and assessment activities is essential for evaluation and effectiveness. Furthermore, if monitoring and assessments are not connected to identified outcomes then, monitoring becomes a means not an end. A well thought plan that connects outcomes/results to monitoring activities and is followed, will provide the structure and function to ensure information is generated and delivered and thus can be evaluated against outcome progress. We don't want to be conducting activities without knowing what the desired outcome the activity is designed to achieve.

Identifying outcomes is not enough however. Desired outcomes are envisioned and owned by people. We must learn *about the people* who will be impacted by the outcome, positive or negative. People who can help make the outcomes real by their passion, position, power, or resources. If we do not consider and include the needs of either the people involved or affected then we cannot design a monitoring and assessment program that will achieve the desired outcome. The foundation is the ability to define and connect what you do with the people it will affect or involve, from the data gatherer, decision maker, action taker or action recipient, the people orientation, the why has to be connected to people, not just a list of monitoring questions.

Exploring the depth of why we do what we do (activities) and want what we want (outcomes) is where we find our passion, connection and motivation. Planning is just another activity if the planning itself is not connected to what we really want or need. Planning will lack clarity, focus, alignment, accountability and credibility. Monitoring is just another activity if it is not based on well thought plan that is connected to an identified result or outcome.

The Steps in this Phase asks you to first develop a vision for your watershed, how you want it to be and further identify outcomes that would tell you that your vision has manifested. This is your true North compass for monitoring and assessment activities. From desired outcomes, the steps in this phase help you *identify unique combinations of monitoring reasons and data uses* that are connected to desired outcomes. Whatever the monitoring or assessment reason may be, it is essential that the reason is identified and articulated. It is essential that each reason be narrowed and specifically articulated. We call this refinement of monitoring reasons, developing specific monitoring questions.

Furthermore, for each monitoring question, it is essential to identify all the individuals who will be making decisions, what their decision could be and what information they need to make the decision. They become the target audience for the monitoring and assessment activity. It is those individuals that you want to get to know and understand their needs for the data and information you are generating. Decision makers range from informal to formal individuals and entities, including you, neighbors, organization members and community all the way to the other end of the continuum to state health departments or a legal/regulatory formal process. The steps in the phase help you refine monitoring data use and *identify who you will target, what decision they can make and identify their information needs*.

In summary, the foundation for rest of this plan is the combination of desired outcomes with identified monitoring reasons articulated by specific monitoring questions that correlate with targeted decision makers and their information needs. This is the foundation, the why and for who, that forms the foundation for the technical sample design (Phase 2), information design (Phase 3) and evaluation design (Phase 4).

**A reminder to you, these Phases and Steps are organized in a linear fashion and as if you are starting from scratch. This is not reality for many entities. You decide where to start. You need to decide the need for, rigor and resources you will put into each step or phase.** If we include a holistic approach you might discover processes, exercises, steps of facets you want to revisit, reconnect or that you missed. We challenge you to connect your monitoring and assessment activities in a meaningful manner for you and your organization, regardless of how small or large your organization or scope is and regardless of how much you are in charge of the decisions to be made.

Phase 1, Steps one through six; describe a process to develop the people component for your scientifically defensible plan to conduct watershed monitoring and assessment activities. The approach is holistic, integrating scientific biological, physical and chemical components with human social, political, cultural and physical components. This planning framework can be applied to any monitoring and assessment program, including streams, lakes and wetlands as well as other ecosystems such as forests, rangelands and deserts.

## The Steps in Phase 1 include:

**Step 1: Share Watershed Vision and Desired Outcomes (Results)**

*What are desired outcomes that monitoring and assessment activities ultimately are will help achieve?*

**Step 2: Scope Inventory (Physical, People and Information)**

*What do you know, have and need to know and have? Identify watershed boundary, water bodies of interest, physical attributes, cultural/historical attributes, status and use, existing data/monitoring efforts.*

**Step 3: Identify Monitoring Reason(s) and Data Use(s) (Assessment Type)**

*Select Specific combinations of monitoring reason plus data use, called Assessment Type.*

**Step 4: Develop Monitoring Questions (Refinement of Monitoring Reason)**

*For each assessment type, develop specific questions the data will answer.*

**Step 5: Target Decision Makers and Info Needs (Refinement of Data Use)**

*For each assessment type and monitoring question, identify specific decision makers, decision they make, information needed to make decision.*

**Step 6: Summarize with Information Blue Print-Data Pathway Fact Sheet**

*For each monitoring question per assessment type, a tool to summarize and communicate the path that each monitoring question will follow from data generation, information, delivery and evaluation while illustrating its connection to desired outcomes.*

## How to Use this Workbook

The overview section provides more introduction and basic background and information. It is highly recommended you read this before you start any Phase or Step. Each Phase and Steps are designed to develop and produce a Watershed Monitoring and Assessment Plan. Each Phase focuses on one critical aspect of an M & A Plan.

The format of each step is designed for you to understand 1) what you can accomplish, 2) why the products of this step are important, 3) what products you will produce, 4) basic steps (activities and worksheets) to produce the products, 5) worksheets and instructions, 6) background and content if you need more understanding to complete basic tasks, 7) case studies, 8) references and 9) resources. Four basic tasks are the same for each step. In the first two basic tasks we ask you to determine who should be involved in planning this step and to identify and evaluate what decisions have already been made regarding the specific step.

The last two basic steps involve putting the products of that step into a master Monitoring and Assessment Plan and to identify any needs you still have regarding that step in order to fully implement your M & A plan and place those in an Action Plan. Thus, both the Monitoring and Assessment Plan and Action Plan are accumulative, adding to an existing document and list after each step. At the end, you have a documented M & A plan and one of the last tasks has you prioritize your Action Plan (from all steps) on a timeline.

The worksheets are designed to be modified to meet your needs and completed electronically. However, they can be completed by hand as well. This is why they are simply formatted in word. The workbook comes with a compact disc for this purpose.

Remember that planning is dynamic, never complete, an iterative and not linear process. The amount of time and rigor you spend on each step is based upon your specific needs. If you skip a step, know why you skipped it. If you don't need to document or communicate or integrate components then don't, but know why. We are suggesting that every monitoring and assessment activity should address or consider all Phases and Steps at the appropriate level.

Start where you are with what is known and expand your horizons. If the step seems too much for your needs, complete what you need and leave the rest. If it seems overwhelming, start with something and do it well. There is no right or wrong, no time limit, just start somewhere. Planning, implementing monitoring and assessment activities is not a black and white science. Embrace that you often will be "breaking trail", there is not clean answers for everything even though there are experts out there, but use what you can that they provide.

In the end if you can justify and articulate your monitor and assessment activities to someone, and can evaluate your results against your goals, then you have succeeded.

Watershed Monitoring and Assessment Design Workbook Phase and Step Illustration



Steps in:

# PHASE I PEOPLE DESIGN



# PHASE I PEOPLE DESIGN



## Step 1: Share Watershed Vision and Desired Outcomes (Results)



"Change is either a force to be feared or an opportunity to be seized. The choice is ours."

**Dr. Janet Lapp**

**About This Step** – *This step is designed to accomplish 7 things:*

1. Provide a measurable context or relevance for monitoring and assessment activities by the following progressive activities, first, develop a shared watershed **vision**, what you want your watershed to look and the organisms in it to behave like, ultimately, or modify an existing vision and/or reconnect with an existing vision. This vision is what the monitoring and assessment plan is accountable to and designed for.
2. Next, identify the individuals, group or entities that are “keepers” of this plan.
3. Next, identify of Individual and Organizational Values.
4. Next, develop a list of desired outcomes (results) for our watershed vision. These are results that if you measured would indicate vision success.
5. Next, identify possible outputs (activities and target audiences) for each outcome. Start with activities. Identify all activities including but not limited to, monitoring and assessment (M & A).
6. Next, identify target audiences for each monitoring and assessment activity. Each activity must have a target audience, thus for each of M & A activities produce a general list of possible decision-makers to influence.
7. Last, summarize, for each M & A activity, use a tool called the Logic Model, to illustrate and communicate how outcomes / results and associated activities and target audiences are

connected to each other and the larger vision. Also, identify what inputs, external factors and assumptions accompany the outcome/output list.

## Why Do This Step?

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*To manifest change.* A dead fish will always “swim” downstream. Without a connection to a clear and empowering vision, the results of our efforts “default” to downstream. We want to know where our watershed is going, be able to visualize, feel and articulate that end point and plan from that vision. A clear, shared vision is the foundation and focus of why we monitor, assess and take action in our watershed. Our watershed vision is the ultimate long term benchmark, end zone or finish line.

I can have the greatest map of Chicago and an address I want to visit, but if I am in L.A. it doesn't matter. I can hire 10 drivers and if they too have a map of Chicago, they can't help me in L.A. either. I can take a bus, taxi or drive around L.A. myself for months, but still won't find my destination in Chicago. We want to work smarter not harder. Visions can seem altruistic and unreachable at times but they are our hearts desires, our dreams and it is imperative we make our day to day work remain connected to our vision.

You can still be effective without a mission or lack of connection to a mission, but real change comes from someone who saw that “it” could be different and manifested that vision. Humans manifest what we think, say and feel, thus we must devote some of our precious life energy to visioning, creating and connecting to that creation.

A **shared** vision is even more powerful equating to a larger success than anyone individual might achieve alone, focused synergy. If we all have a similar view of what the world could look like, then together we have a better chance of achieving it. This happens because we take the time to vision, share that vision and connect with others. The process of sharing a vision includes inviting the people who have common values and interest in the outcomes to participate in experiencing, shaping, refreshing, or defining the vision and values guiding the project. The process for creating a shared vision and outcomes might include designing and conducting a visioning event and then disseminating, marketing and gaining endorsement.

*To create synergy.* What we each choose to do originate from our individual personal values and heart desires. The perfect vision for all our lives would be a life in which all our individual values were constantly honored. Organizations also have values, spoken or unspoken, for which they employ to manifest their missions. In theory, individuals within an organization will have some common individual values with those of the organization. This alignment can happen without ever identifying organizational values or individual values. When alignment does happen there is a synergy everyone experiences.

When alignment does not, conflict usually arises. Often the source of conflict is a perceived violation of an individual value or organizational value. Lack of alignment is an unnecessary source of energy drain, misunderstandings, unmet expectations, position cementing, direction creep, wasted resources and miscommunication. We can avoid needless suffering, conflict, be authentic in achieving our vision, mission and outcomes, if we can identify our individual values, organizational values and the

commonalities or lack of. Consciousness about our values, individual and organizational, become a tool to strategically align you with volunteers, partners and stakeholders with common values or can accept difference from a value place, not a positional place.

*Focus Resources and Design Evaluation.* A watershed vision is the big benchmark, providing the context for in which you consciously choose to focus your energy. Once a vision is agreed upon, celebrated, shared and communicated, the hard work of planning how to get there begins. There is no right or wrong way to plan to get to the vision, however the results we strive for and the activities we conduct with the audiences we target should all be derived from the vision. We will suggest a method that helps illustrate the logic that *connects or links* where we want to end up (watershed vision) with

- ◆ Identifiable short, medium and long term results or outcomes that would tell us we have achieved the vision by conducting/producing outputs (activity + target audience) specifically,
- ◆ Output 1a = what we do to get there (activities) and
- ◆ Output 1b = who we work with (target audiences and decision makers) and identify the
- ◆ External factors, assumptions and inputs that provide the boundaries or limitations for the above combination of outcomes and outputs.

Desired outcomes or results should drive the activities and target audience, not the other way around. Your organization should be vision and result driven, not activity and audience driven. In addition, illustrating how these items are logically connected helps us design effective evaluation of our progress.

One possible result of completing this step might be the realization that monitoring is not the best activity to achieve desired results. Or you may discover that monitoring may not be most appropriate for your organization in particular, or simply may not be a priority. You may also discover that your target audience and or decision-maker is not appropriate or realistic. You may discover a decision maker you never considered. The reason for visioning and identifying outcomes to measure the vision, then plan activities with identified audiences to so that our work will be strategic, efficient and defensible before we expend more resources.

## Where are we in the Big Picture Illustration?

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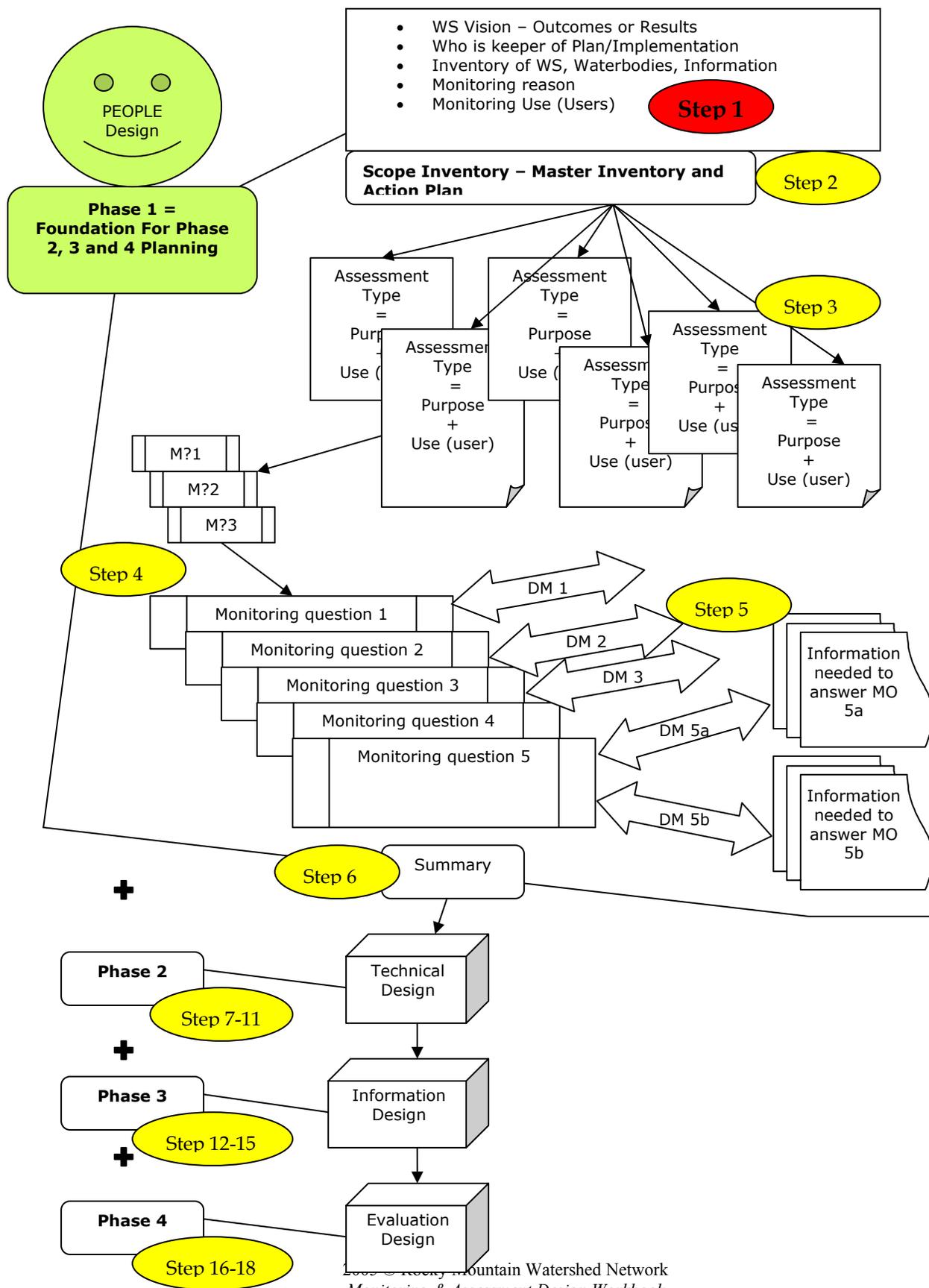
|         |   |
|---------|---|
| Phase 1 |  <b>Step 1: Share Watershed Vision and Desired Outcomes (Results)</b><br>Step 2: Scope Inventory (Physical, People and Information)<br>Step 3: Identify Monitoring Reason(s) and Data Use(s) (Assessment Type)<br>Step 4: Develop Monitoring Questions (Refinement of Monitoring Reason)<br>Step 5: Target Decision Makers and Info Needs (Refinement of Data Use)<br>Step 6: Summarize with Information Blue Print-Data Pathway Fact Sheet) |
| Phase 2 | Step 7: What Will You Monitor?<br>Step 8: When Will You Monitor?<br>Step 9: Where Will You Monitor?<br>Step 10: How Will You Monitor to Meet Data Quality Objectives?<br>Step 11: Management of Raw Data (Data Management Plan Part 1)  |
| Phase 3 | Step 12: Data Summary and Analysis<br>Step 13: Interpretation, Conclusions and Recommendations<br>Step 14: Communicating and Delivery<br>Step 15: Management to Generate Info (Data Management Plan Part 2)   |
| Phase 4 | Step 16: Who Will Do What? Task Identification<br>Step 17: Evaluation of Effectiveness (of Plan and Implementation)<br>Step 18: Documentation and Communication (of M & A Plan)   |

## Products (see Figure Phase Product List):

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- ✓ A measurable context for monitoring and assessment activities, a shared watershed vision with a defined geographic scope, scale and timeframe.
- ✓ A strategy to share that watershed vision.
- ✓ Identification of who makes what type of decisions in your organization for effective planning, who should be involved in vision, a monitoring and assessment plan and their potential role.
- ✓ Identification who are the “keepers” of this plan and process.
- ✓ Identification and connection with personal and organizational values.
- ✓ A list of possible short, medium and long term outcomes (results) that indicate the vision is real.
- ✓ Possible outputs (activities and target audiences) that involve M & A activities.
- ✓ For outputs that involve M & A activities the general M & A purpose and associated decision makers and desired decisions.
- ✓ A format to illustrate and communicate all this work, called the Logic Model, illustrating the connection between the watershed vision (situation), desired outcomes, outputs related to monitoring and assessment and associated decision makers and the boundaries on this information such as inputs, assumptions and external factors.

Phase 1 Product Illustration:



## What Should Be Done Before This Step

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If you do not have a current monitoring and assessment plan, or have a plan but it is not meaningful, or do not have any monitoring data yet, or perhaps have a few energized people in need of focus, and or something similar, then you are lucky and can start at the beginning, Step 1. At the end of this planning process and consideration of all Phases and Steps you will have a scientific, defensible plan for which to implement and evaluate.

If you have been monitoring and have data with or without a plan, have been doing assessment, or perhaps are stuck somewhere between data generation, data analyses, data interpretation, reporting and or delivery to a decision maker, then the place to start is with an evaluation of where you are at, today. Stop, and assess where you are at and reconnect with where you are going. It is never, ever too late to plan. We believe that in the business of watershed monitoring and assessment the cost savings of planning is an understated and under valued. Any resources that are expended on planning (that is connected to values) will be far less than resources wasted during implementation because there was a lack of planning.

Thus, all that is needed for this step is a desire to evaluate your monitoring and assessment activities and connect them to identified outcomes and results.

## Basic Tasks

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Basic Tasks are numbered to correlate with the overall 1-18 Steps provided in these guidance modules followed by the basic task sequence step to complete. For example Step 4, basic task 2 would be numbered as Basic Task Step 4.2, Step 3.3 correlates to Step 3, Basic Task 3.



- 1.1 Identify who will make the decisions about this step and who should be involved in the planning process (they may be different).



- 1.2 Self Assessment: Identify what decisions have been made and their effectiveness. Monitoring and Assessment Organization Decision Chart.



- 1.3 Identify the “keepers” of this plan and the planning process.



- 1.4 Identify personal values (important to connect and align with work).



- 1.5 Identify organization values (important to connect and align with work).



- 1.6 Vision Creation or Reconnection, documentation and sharing:

Whether you are modifying an old vision, reconnecting with an old vision, or starting from scratch, create a vision of what you want your watershed to look like and how the organisms in it to behave. This involves four basic actions, a) determine the process, b) put the vision in writing, c) delineate the watershed boundary for the vision, and d) develop a plan to share the vision.



- 1.7 Watershed Vision Outcomes or results. With your vision in front of you, develop a set of desired outcomes, results, changes you need to see to achieve your vision.



- 1.8 Activities and Target Audiences (outputs) to achieve Watershed Vision Outcomes. For each outcome on your list develop a set of outputs (activities and target audiences) to achieve that outcome (result).



- 1.9 From list in 1.8, identify all outcomes and associated outputs that involve monitoring or assessment. Expand on the target audiences for all monitoring activities by listing the

possible set of decision makers and type of decisions they make for each output that involves monitoring.



1.10 Summarize, place outcomes and outputs that involve monitoring into logic model.

**Situation is watershed vision.** List desired ST, MT and LT outcomes (results) and associated outputs (activities and audiences), aligning one to many relationships, one outcome to many outputs or one output to many outcomes.



1.11 Start a *Watershed Monitoring and Assessment Plan* and place the products in from this Step in it, you will build on this document in each following Step.



1.12 Start an *Action Plan*, to identified gaps and needs regarding this step, this will be a progressive activity as you finish each Step. This accompanies the *Watershed Monitoring and Assessment Plan* to assist with fulfilling needs in order to fully implement desired monitoring and assessment plans.

## Worksheets

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Worksheets are listed below. Not all Basic Tasks have an associated work sheet. To simplify completion of products for each step, the worksheets or broken into small subsets of tasks. This requires moving the results of one task into the next task and will seem redundant, especially if completing worksheets by hand. Worksheets are provided in word here for ease of reproducibility. These are a starting point; we encourage you to customize these and reproduced them in an electronic format, in Excel for example, where it is easy to move information from one area to another by cutting and pasting.

Work Sheets are numbered to correlate with Basic Steps and the overall Steps in these guidance modules. Each consecutive work sheet is lettered a, b, c and so forth, preceded by the Basic Task sequence step, preceded by the Step number. For example, *Worksheet Step 4.2.a* and *Step 4.2.b*, correlates to Step 4, Basic Task 2, Worksheet a and Worksheet b. In theory worksheet *a* needs to be completed before worksheet *b*.

|                         |  |
|-------------------------|--|
| <b>Worksheet 1.2.a</b>  | <b>Self Assessment Step1 Worksheet and Products to be completed Prior to this Step</b>   |
| <b>Worksheet 1.2.b</b>  | <b>Monitoring and Assessment Organization Decision Making Chart</b>  |
| <b>Worksheet 1.3.a</b>  | <b>Identify keepers of the monitoring and assessment plan and process</b>  |
| <b>Worksheet 1.4.a</b>  | <b>Identify personal values (important to connect and align with work)</b>   |
| <b>Worksheet 1.5.a</b>  | <b>Identify organization values (important to connect and align with work)</b>   |
| <b>Worksheet 1.6.a</b>  | <b>Watershed Vision Creation or Reconnection, documentation and sharing</b>  |
| <b>Worksheet 1.7a</b>   | <b>Watershed Vision Outcomes or Results</b>  |
| <b>Worksheet 1.8.a</b>  | <b>Activities and Target Audiences to achieve Outcomes</b>   |
| <b>Worksheet 1.9.a</b>  | <b>Potential Targeted Decision makers (audience) for monitoring and assessment activities identified to achieve desired outcomes</b> |
| <b>Worksheet 1.10.a</b> | <b>Summarize, place outcomes and outputs that involve monitoring into logic model</b>  |
| <b>Worksheet 1.11.a</b> | <b>Start your <i>Watershed Monitoring and Assessment Plan</i> and place the results of this step in that plan</b>                    |
| <b>Worksheet 1.12.a</b> | <b>Start your <i>Final Action Plan Part 1</i></b>  |

## How to do Worksheets

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**For Sheet 1.2.a      Self Assessment: Identify what decisions have been made and their effectiveness.**

Part 1. Complete the self assessment section of the worksheet to evaluate what you have or what decisions have already been made. This will help you focus on what you need from this step and incorporate valuable existing information or products into this plan.

Part 2. Next, to prepare to complete this step the following, you need to have the following items addressed:

- ✓ A vision for your watershed, formal or informal
- ✓ Desired set of outcomes or results that the monitoring and assessment activities will be designed to help achieve
- ✓ Generally identified monitoring and assessment activities,

This is the ideal list, if you do not have any of these, they become a gap or need that should be addressed before any data is collected or analyzed, even if the answers aren't perfect or you don't have a large degree of confidence surrounding them, they should be attempted as the starting point. This is what you are evaluating in this step-your monitoring and assessment plan.

**Worksheet 1.2.a Self Assessment Step 1 Worksheet and Products to be completed Prior to this Step, Part 1**

*Part 1 Self Assessment of Known Evaluation Products and Processes*

- 1. Determine if you "have" or "don't have" the item, mark the appropriate box. If you don't have it and determine you don't need it, explain why in the comments document. You may not need to know but perhaps your target decision makers, board or membership might want to know.**
- 2. If you have the item "documented", mark that box. If so, list in the comments where, hard copy, chapter in a document, electronic file name and location, etc. The assumption is you value the ultimate goal to document and communicate your M & A plan, activities and results.**
- 3. If you have the item, assess the use of it, use the scale below or provide your own answer and comments.**

Rating Scale for USE:

- 0=doesn't exist so use is nil
- 1=don't know why would need or understand item
- 2=exists, don't know where it is, if it is used, etc. so use is essentially nil
- 3=exists and use some of time
- 4=exists and use all the time
- 5=wish it existed, would use it lots

- 4. If you have the item, assess the effectiveness of it, just because something exists or is used does not mean it is effective in its use, use the effectiveness scale below or provide your own answer and comments.**

Rating Scale for EFFECTIVENESS, assumes material exists:

- 0=not effective or functional at all
- 1=incomplete (all elements are not there) and some existing parts need revising
- 2=incomplete but what is there is okay
- 3=complete (all elements are there), some parts okay but need revising
- 4=complete and effective

| Item   | Have | Don't Have | DOC | Assessment of Use (Scale 0-5) | Assessment of Value / Effectiveness (Scale 0-4) | Comments |
|--|------|------------|-----|-------------------------------|---|----------|
| 1. Written Vision Statement for future of watershed conditions (or for your assessment)            |      |            |     |                               |   |          |
| 2. Outcomes that are measurable or would indicate directly or indirectly the success of the vision |      |            |     |                               |   |          |
| 3. Written Organizational Mission Statement  |      |            |     |                               |   |          |
| 4. Organizational values   |      |            |     |                               |   |          |
| Other?   |      |            |     |                               |   |          |

\*DOC=Documentation, \*M & A= Monitoring and Assessment

**5. To make this assessment useful, determine what your gaps and needs are regarding this step in order to focus your effort in completing this step.**

**Worksheet 1.2.a Self Assessment Step 1 Worksheet and Products to be completed Prior to this Step, Part 2**

*Part 2 Products to be completed before this step, in order to complete this step*

| Item  | Response |
|---|----------|
| General Idea of “what” the “group” is rallying around and the common ground, whether it is a water body, a threat, a situation or the like. |          |
| General Idea of who will be the keepers of this monitoring and assessment plan and implementation effort?                                   |          |
| A general inventory and evaluation of existing monitoring and assessment activities, purpose, technical design, effectiveness, etc.         |          |

**For Sheet 1.2.b      Monitoring and Assessment Organization Decision Making Chart**

To further the effort of developing a monitoring and assessment plan as part of a watershed vision you can assess decision making within the organization using the following tool or a modification of it. If this chart does not serve your needs develop another way to assess who makes the decisions in order to involve them and effectively plan.

Diagram or chart that illustrates who has the authority to make the following decisions, how they make them and your relationship to them. If an item does not apply to you skip it. Do for every project or program if more applicable. Break it out however it is meaningful, but identify decision making authority and process.

**Worksheet 1.2.b Monitoring and Assessment Organization Decision Making Chart**

| Item  | Authority | How decision is made<br>Choose 1, 2, 3, or 4* | Relationship to them |
|---|-----------|---|----------------------|
| 1. Organization Vision  |           |   |                      |
| 2. Organization Mission   |           |   |                      |
| 3. Unit Mission   |           |   |                      |
| 4. Desired organizational outcomes  |           |   |                      |
| 5. Key stakeholders   |           |   |                      |
| 6. Monitoring activities  |           |   |                      |
| 7. Monitoring questions   |           |   |                      |
| 8. Targeted Decision Makers   |           |   |                      |
| 9. What monitor   |           |   |                      |
| 10. Where monitor   |           |   |                      |
| 11. When monitor  |           |   |                      |
| 12. Sample collection/analyses methods  |           |   |                      |
| 13. Data quality  |           |   |                      |
| 14. Monitoring Equipment  |           |   |                      |
| 15. Laboratories  |           |   |                      |
| 16. Computer equipment  |           |   |                      |
| 17. Data management   |           |   |                      |
| 18. Data analyses/findings  |           |   |                      |
| 19. Data interpretation/conclusions   |           |   |                      |
| 20. Data recommendation/action  |           |   |                      |
| 21. Data reporting  |           |   |                      |
| 22. Monitoring Design as a whole  |           |   |                      |
| 23. Assignment of tasks   |           |   |                      |
| <p><b>* Key to How Decisions are made:</b><br/>                     1 = dictator, only they decide, no participation<br/>                     2 = False consensus=they say you have a say, but have mind made up already, no meaningful participation<br/>                     3 = Partial Consensus=you recommend, they ask/dialogue, they still decide, some degree of participation<br/>                     4 = complete consensus, collaboration and participation</p> |           |   |                      |

**For Sheet 1.3.a Identify keepers of the monitoring and assessment plan and process.**

Identify who will be the keepers of this plan and the planning process. Document this in a manner that serves your needs, might be a formal memorandum of understanding or a simple address list and verbal commitment. It is important to be clear who is involved, what their role and responsibility is and how decisions will be made, for planning as well as implementation.

**Worksheet 1.3.a Identify keepers of the monitoring and assessment plan and process.**

| Who | Organization/Role | Responsibility | Contact Information |
|-----|-------------------|----------------|---------------------|
| 1.  |                   |                |                     |
| 2.  |                   |                |                     |
| 3.  |                   |                |                     |
| 4.  |                   |                |                     |
| 5.  |                   |                |                     |
| 6.  |                   |                |                     |
| 7.  |                   |                |                     |
| 8.  |                   |                |                     |

**How do we agree planning decisions will be made?**

**For Sheet 1.4.a Identify personal values.**

This is important. Conflict is inevitable when we are not conscious of aligning our values with how we choose to spend time, at work, with friends, etc. The goal of this exercise may be valuable for other purposes but here we are trying to identify the common ground between individual values, organizational values and the watershed vision or outcomes we are all working toward. This is very powerful because it connects people from a value perspective versus a position perspective. People will work together that have different positions but the same core value. Modify worksheet to serve your needs.

- ◆ First step is to identify values (column 1).
- ◆ The next step is to describe those values with a variety of adjectives or a sentence, because one word can mean many things (column 2).
- ◆ The next step is to prioritize these values (column 3).
- ◆ The next step is to rank each value from 1-10, 1 being not honored all today and 10 being fully honored today. This tells you how decisions you are making are either honoring or not honoring your values (column 4).
- ◆ The final step is to take action, keep on doing what is honoring your values and determine what you can change if a value is not being honored and is a priority now.

**Worksheet 1.4.a Identify personal values (important to connect and align with work).**

| Value | Description | Prioritize | Rank<br>1-10 |
|-------|-------------|------------|--------------|
| 1.    |             |            |              |
| 2.    |             |            |              |
| 3.    |             |            |              |
| 4.    |             |            |              |
| 5.    |             |            |              |
| 6.    |             |            |              |
| 7.    |             |            |              |

**For Sheet 1.5.a Identify organization values.**

This worksheet is similar to Step 1.4.a Worksheet, but from an organizational perspective. If the keeper of this monitoring and assessment plan is a collaboration of multiple organizations, you can complete this from the collaboration’s perspective. Again, the goal is to identify core values between organizations, within organizations and individuals. People make daily decisions based upon their core values, aligning them with an effort is sustainable and reduces conflict and provides the glue for individuals or organizations with similar values but different positions to work together.

- ◆ First step is to employ a process that involves everyone and identifies core values (column 1).
- ◆ The next step is to describe those values with a variety of adjectives or a sentence, because one word can mean many things (column 2).
- ◆ The next step is to prioritize these values (column 3).
- ◆ The next step is to rank each value from 1-10, 1 being not honored all today and 10 being fully honored today. This tells you how decisions you are making are either honoring or not honoring your values (column 4). This column can be used during an evaluation as well.
- ◆ The final step is to take action, keep on doing what is honoring your values and determine what you can change if a value is not being honored and is a priority now.

**Worksheet 1.5.a Identify organization values (important to connect and align with work).**

| Values | Description | Prioritize | Rank<br>1-10 |
|--------|-------------|------------|--------------|
| 1.     |             |            |              |
| 2.     |             |            |              |
| 3.     |             |            |              |
| 4.     |             |            |              |
| 5.     |             |            |              |
| 6.     |             |            |              |
| 7.     |             |            |              |

**For Sheet 1.6.a      Watershed Vision creation, documentation, sharing.**

Whether you are modifying an old vision, reconnecting with an old vision, or starting from scratch, create a vision of what you want your watershed to look like and how the organisms in it to behave.

This involves four basic actions:

1. Determine what process you will employ to develop/modify this vision, who should be involved when, refer to the Background and Content Section for Ideas. Once you have a process, implement it to create or reconnect with a watershed vision.
2. Put the watershed vision in writing and be as specific as appropriate. The result should include a defined scale, scope and connect with the common individual and organizational values.
3. Delineate the watershed boundary that serves this vision, sketch the geographic boundaries that the watershed vision pertains too, place identifiers like water bodies, cities, etc. that provide context for a user.
4. Develop a plan or strategy to share your watershed vision and if helpful illustrate it. Put the vision in your literature, have it on your logo, include it in your presentations, sponsor coffee breaks to share it with others, etc. Identify at least five target audiences and a strategy to share the vision with them. For example, general public=put vision on brochure, fact sheet and website, for Board=ask them for signed endorsement, post in main office, for monitoring coalition=signed memorandum of understanding with roles/responsibilities. See Background and Content section for more ideas and explanations and the value / power of visioning.

**Worksheet 1.6.a Watershed Vision Creation or Reconnection, documentation and sharing.**

**WATERSHED VISION:**

**WATERSHED BOUNDARIES FOR WATERSHED VISION**

**ACTION ITEMS TO SHARE WATERSHED VISION:**

| Target Audience | Strategy to Share Vision: |
|-----------------|---------------------------|
|                 |                           |
|                 |                           |
|                 |                           |
|                 |                           |
|                 |                           |

**For Sheet 1.7.a Watershed Vision Outcomes or Results.**

With your watershed vision in hand, brainstorm a list of all the possible outcomes or results you would like to see as a result of your vision. Outcomes are measurable, maybe difficult to measure, but they are indicators of progress towards your vision. For example, Vision=Waters meet all plant and animal uses...

Outcome 1: Improve water quality to support coldwater fishery

Output: increase riparian vegetation to assure that average daily temperature remains below 19 degrees Celsius during the summer (where, before after measure?)

Outcome 2: Improve stream bank cover and stability to decrease bank erosion

Output: increase stream bank cover on stream banks so that 80-90% of the banks are rated as covered and stable (in what streams, what rating?)

\*Require comparison of existing to reference or expected condition

If you don't have a watershed vision you can still do this, simply list all "things" you want to see, happen, change. What do you want the results of your work, monitoring, assessment, education campaign, training, etc. to be? What are some statements you could make if you could see or witness the changes or desired conditions? These are all ideas to generate as many outcomes as possible, including but not limited to monitoring and assessment. Modify worksheet to meet your needs to list desired outcomes.

**Worksheet 1.7a Vision Outcomes or Results.**

| Watershed Vision: |          |
|-------------------|----------|
| ID                | Outcome: |
| 1.                |          |
| 2.                |          |
|                   |          |
|                   |          |
|                   |          |
|                   |          |
|                   |          |
|                   |          |

**For Sheet 1.8.a      Activities/Target Audience (Outputs) for every Outcome.**

For each outcome you have listed above, brainstorm a list of all the possible activities you could employ or implement to achieve that outcome or result. For each activity, list the potential audience such as youth or adults, or farmers, or girl scouts or lake front property owners. Don't worry about "how" you would do these activities or reach these audiences. Include all types of activities in addition to monitoring, such campaigns, education, sign posting, etc. If you can't produce this list you may need to involve more folks.

Do not worry who will be implementing the task, don't judge them, just list it all activities that could achieve your vision via that specific outcome or result. This list is the master list of the possible outcomes and associated activities/audiences that could make the watershed vision manifest. This can be useful for future organizational planning.

Modify the worksheet to suit your needs. Cut and paste the table from Worksheet 1.7.a and add on.

The rule is that every outcome or result is achieved by doing "something" (activity) for "someone" (target audience). One outcome may have multiple outputs or activity/audiences. One activity might have multiple audiences. However, every activity must have a target audience, the more specific you are the easier it will be to measure success.

Likewise, one activity/target audience may be helping you achieve multiple outcomes/results. Don't worry about repetition, list multiple audiences and activities. The point is to know what results you want and plan the activities and target audiences accordingly, not visa versa where you do an activity or target an audience and figure something good will happen. The goal is to be result driven, not activity driven, this type of planning sets the stage for evaluation to not only occur but be measurable.



**For Sheet 1.9.a**      **Identify all outcomes and associated outputs that involve monitoring or assessment. Expand on the target audiences for all monitoring activities by listing the possible set of decision makers and type of decisions they make for each output that involves monitoring.**

Identify all the activities that involve monitoring and assessment that you want to develop a plan for, it would be easiest to cut and paste these from Worksheet 1.8.a. For each monitoring and assessment activity, list the potential decision makers and the general decision they would make with the results generated from monitoring, what is the assessment they would make?

Creating this list does not mean you have to actually target each decision maker you list, but it is a start to identify who you will target. Knowing who the decision makers are and what decisions they will make is essential to measuring progress. You may learn something and even change your focus.

Decision makers are defined here as anyone who will do something with the data that you plan on doing something with it, you target them. So, it could be just you, your organization, a stakeholder group, a local rancher, the city council, the state department of health. Decision maker for this purpose is not anyone who *might* use your data somewhere down the line without your intent.

Modify the following worksheet to serve your needs.



**For Sheet 1.10.a      Summarize, place outcomes and outputs that involve monitoring into a summary format, Logic Model.**

We encourage you to find a way to summarize this information for planning, evaluation and communicating what you are doing and not doing. One tool to use is the Logic Model. Like its name implies it is way to display the logical connections between what you are doing, with whom and why. This tool also allows you to identify and articulate the inputs needed, assumptions made and external factors acting on the activities to achieve outcomes that move you closer to the watershed vision. See Background and Content and *Step 1 Resource Guide* for more information and examples.

The Logic Model requires that you identify a situation or a context for what you are logically laying out as results, activities and target audiences. Here, the **situation is the watershed vision, monitoring and assessment component**. The worksheet has you put the information you generated in previous steps into a format that is easy to understand and use for further planning and evaluation.

You have the opportunity to list outcomes in a time frame, short, mid and long term. You can assign these time frames any value. Typically, short term is around 1-5 years, mid-term 5-10 years and long term 10 plus, but it really is situation specific. Another view of these time frames can be that short term is for informing and education a target audience and gathering information, mid-term is when behaviors might change due to education or information and when you might be analyzing/interpreting data generated, conducting restoration activities, etc., and long term is when you might be able to measure changes in conditions due to behavior changes or are monitoring the results of restoration activities, etc. Again, do what is relevant and meaningful to your work. This is also an opportunity to lump multiple activities/target audiences that serve one outcome.

Stray from the format if need to , but try and provide the equivalent information. Do not worry about documenting the “how’s”, that is not the purpose of the Logic Model. The purpose is to communicate what you are doing (activities) for whom (targeted audience) for what purpose (outcome/result).

You can also include all activities/target audiences, not just those that involve monitoring and make this logic model complete. In theory you plan from right to left, determine outcomes/results first, then activities/target audiences to achieve outcomes. You evaluate from left to right. Did your activity/target audience achieve the outcome it was design for, how do you know?

Include inputs, assumptions and external factors that accompany the outputs and outcomes. These can be invaluable as time goes on, staff changes, boards and funders need to be reminded what was “in” place when monitoring started, etc. You may employ the logic model for all programs, any aspect of achieving your watershed vision, not just monitoring activities. Just provide the Situation or context.

Modify the worksheet to accommodate your information and needs. Change the view to landscape if that is helpful. The format is not as important as the information.

Worksheet 1.10.a Summarize, place outcomes and outputs that involve monitoring into logic model. (If you want to add inputs, add a column to the far left).

| <b>Situation: Watershed Vision:</b> |                 |                         |          |           |
|-------------------------------------|-----------------|-------------------------|----------|-----------|
| <b>Outputs</b>                      |                 | <b>Outcomes</b>         |          |           |
| <b>Activities</b>                   | <b>Audience</b> |                         |          |           |
| What We do                          | Who we Target   | Short Term              | Mid Term | Long Term |
|                                     |                 |                         |          |           |
| <b>Assumptions:</b>                 |                 | <b>External Factors</b> |          |           |
|                                     |                 |                         |          |           |

**For Sheet 1.11.a Place Products in your *Watershed Monitoring and Assessment Plan*.**

- ➔ Watershed Vision and plan to communicate
- ➔ Desired Outcomes (results)
- ➔ Who will be involved and responsible for this *Monitoring and Assessment Plan*
- ➔ Mechanism to communicate what doing (activities) for whom (target audiences) to achieve desired outcomes

**Worksheet 1.11.a Place Products in your *Watershed Monitoring and Assessment Plan*.**

I. People Design, Phase 1

- A. ➔ Shared Watershed Vision and Desired Outcomes (Step 1)
  - 1. ➔ Logic Model of Desired Outcomes/Results and activities/target audiences to employ to achieve outcomes
- B. ➔ Keepers of the M & A Plan (Step 1)
- C. Watershed Boundary (Step 2)
- D. Water bodies of Interest (Step 2)
- E. Scope *Master Inventory List\** (Step 2)
  - 1. Physical Inventory \* (Step 2)
  - 2. People Inventory\* (Step 2)
  - 3. Information Inventory\* (Step 2)
    - a. Existing Monitoring Efforts (Step 2)
    - b. Existing Data Sources (Step 2)
  - 4. *Inventory Action Plan\** (Step 2)
- F. Assessment Type(s) List - Monitoring Reason + Use (Step 3)
  - 1. Monitoring Question(s) (Step 4)
  - 2. Targeted Decision Maker(s) (Step 5)
    - a. Information Needs (Step 5)
  - 3. Information Blue Print - Data Pathway Fact Sheet Per Monitoring Question\* (Step 6)

II. Technical Design, Phase 2

- A. What (Indicators, Benchmarks, etc.) and why? (Step 7)

- B. When and why? (Step 8)
- C. Where and why? (Step 9)
- D. W(how) will meet data quality objectives? (Step 10)
  - 1. Data quality objectives (Step 5 and 10)
  - 2. Quality Assurance and Control Measures (Quality Assurance and Control Plan)\* (Step 10)
- E. Data Management for Raw Data (Data Management Plan Part 1)\* (Step 11)

### III. Information Design, Phase 3

- A. Data Summary and Analyses (Step 12)
  - 1. Starting Point (Step 12)
  - 2. Changes (Later)
- B. Data Interpretation, Conclusions, Recommendations
  - 1. Starting Point (Step 13)
  - 2. Changes (Later)
- C. Communication and Delivery
  - 1. Starting Point (Step 14)
  - 2. Changes (Later)
- D. Management Plans to Generate Information (Data Management Plan Part 2)\* (Step 15)

### IV. Evaluation Design, Phase 4

- A. Who Will Do What? (Step 16)
  - 1. Task Identification Matrix (Step 16)
  - 2. Communication Structure and Tools (Step 16)
- B. Evaluation Plans (Step 17)
  - 1. Evaluation Plans for M & A Components (Step 17)
  - 2. Evaluation Plans for M & A Implementation (Step 17)
  - 3. Evaluation of inter/intra M & A Activities (Step 17)
- C. Documentation and Communication (Step 18)

1. M & A Plan (**this document**, updated Sub documents) (Step 18)
2. Communication and Peer Review Plan (Step 18)
3. Action Plan\* (Step 17)

**For Sheet 1.12.a**      **Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan).**

**Worksheet 1.12.a**      **Final *Action Plan* Part 1, Summary:**

*If you have completed each Step, or for those you have, you have a cumulated list of gaps and needs related to that Step. Use that same worksheet/document. If you did not complete each Step, look at what each Step is supposed to accomplish and record what your gaps and needs are related to that topic. The goals are to get the gaps and needs in one place to evaluate and prioritize.*

**Phase 1 Step 1:**

**Phase 2, 3 and 4 Steps: Will add Action and Needs as complete each Step and at the end prioritize**

## Background and Content

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### Self Assessment

Either employ the self assessment questions provided or your own set, but evaluate your status and need for the products or processes in this step. Any needs that can be addressed now do so and if not, document in the provided Action Plan or an equivalent document that will serve to assist future planning and activities.

Do you have a vision of how you want the waters in your watershed to be in 5, 10 and 50 years? Have you shared your vision with staff, board members, community members and decision makers? Do you have a vision of what processes, standards, regulations, relationships, information need to be in place to manifest that vision? Do you have an idea of who needs to be involved? Have you identified target results that indicate the vision is a reality? Are your target results the driver for determining what activities you do and who you target? Do you have a mechanism to communicate what you do with what you expect as an outcome with a larger vision?

If you answered no to any of these questions, you can address that issue in this chapter.

### Determination of Who Makes What Decisions and Who Should be Involved.

#### Who makes decisions?

In the context of creating a watershed vision and associated monitoring and assessment plan, identify who else should be involved and how (creation, provide input, just be informed, etc.). This exercise can be completed in general or in great detail. It can also be used for other work such as improving relationships and training. You determine what level is valuable. At a minimum determine identify who is important to include in the creating or reconnected with a watershed vision.

It is important to identify who makes what decisions to design a successful monitoring and assessment program. This is important for sustainability, evaluation, developing support, obtaining or maintaining resources. If you need to change or modify monitoring components, you need to know who has that authority. You also need to identify the communication structure between authority for the decision, those doing the task and where the accountability lies. It can be that they are the same person, but they may not be. When they are two different people (or more), it pays to clarify what accountability lies where. Who is responsible for each monitoring design component is discussed further in this planning process. It is very common that many projects failure lie in not identifying and communicating decision making processes in your organization. You may discover your monitoring design is just fine; it is the communication that is not working

#### How are key decisions made?

If you are the organization, or the primary decision maker, enough cannot be said to defining and communicating what type of decisions are made and how to your staff, peers, stakeholders, volunteers, constituencies, board, decision-makers and other key individuals. Needless suffering occurs when we don't know how decisions are made that are important to us or affect us. As

humans, when we don't know, we make the process up based on how our perception of how it should be, and then when it is not, we feel frustration, alienation, hopelessness and other negative feelings, because as humans we all have need for clarity, to know how the decision that affect us will be made. I may not like the process, but that is different than not knowing what the process is.

**Who should be involved?**

Related to creating a watershed vision, identify who inside and outside the organization that should be involved with the creation of it, the implementation and who should know about it. Who should be involved in designing your monitoring and assessment plan might be a different list, same activity different focus, different result.

**Identification of the Monitoring and Assessment Plan and Process**

Identify who the key individuals and entities that will be responsible for this monitoring assessment plan development and documentation. They are the 'keepers' of the planning process you are embarking upon. They may or may not be the long term keepers of the plan or planning process, or the implementation and evaluation of the plan. They are however, who you have identified to help in all or various aspects of developing and scientific, defensible plan that can be implemented and evaluated.

**Identification of Personal Values and Organizational Values**

Identifying our individual values and those of the organization is where our authenticity and power comes from. It is from our values that we want to make decisions about what we will do, who we will work with, what and who we hope to affect, who we will accept resources from and the like.

Our values support our beliefs systems and our belief systems create the paradigms we operate in, around and from. Values are often universal. They are ways of being and ways we wish other would be-or our needs are met when we experience our values being honored or validated. The greatest point of influence on ourselves or on others is going to be at that paradigm, belief and value level. That is because significant long term change results when we choose from our hearts, not our reactions or what we are busy doing.

Values are thoughts and beliefs and needs that we all have. They may come from our parents, ethnicity, childhood, experiences and where we live for example. They may be things like, integrity, fun or honesty. Think of them as 'ways of being' that make you, you or your organization what it is.

Most conflicts we encounter arise over perceived threats to:

- ◆ values, traditions or boundaries
- ◆ goals, organizational, individual goals for the organization or personal
- ◆ Personal laws, "my way of doing things"

Your core values become the bar that all else is measured. If for example excellence is a core value, the question begs then in the moment of decision, where will I place my excellence? If it is integrity or reverence, how will that affect the work we choose to do? Organization values are honored when the

values of a minimum number of individuals are aligned with the values of the organization. Values are manifested into action by walking our talks.

Identify your personal values by brainstorming the top 10. Review the process of brainstorming provided in the *Step 1 Resource Guide* to understand that it is a process of creating without judgment followed by assessment and then choice. For every value listed, brainstorm words that expand upon that value. For example a value of freedom might be expanded into independence, autonomy, community and creativity. An additional activity can include listing these 10 (or more) values into order of importance and then finally ranking each value from 0-5 has to how it is actually being honored at this time in your life (0 being not at all and 5 being all the time). A follow up to this activity is to consciously determine activities and strategies we individually employ that either preserve and honor our values or do not and how we might change that.

This exercise can be done privately, or it is not uncommon to involve all staff or key staff in this exercise. Sharing our individual values with our peers communicates to everyone how everyone “fits” and why they are there from a values perspective, it shares our common ground. Individuals who seem very opposite in style or personality will learn they might have something very personal in common with their opposite.

After identifying with your own values it is time to identify the values of your organization, brainstorm or list at least 10 organizational values. Review the process of brainstorming provided in the *Step 1 Resource Guide* to understand that it is a process of creating without judgment followed by assessment and then choice. For every value listed, brainstorm words that expand upon that value. Every organization has values. Values may be formally written or known and unspoken. Focus on what is desired of the organization versus your perception of what the organization may or may not be “doing”. Individual and organizational integrity are rooted in alignment between values and choices, action or decisions. Brainstorm an expansion of each of the ten organizational values. If appropriate prioritize the values and rank them as to how they are being honored (and how those that are might be preserved and those that are not might be rectified).

Organizational values should be the benchmark all decisions are weighed in against and the fuel supporting all decisions. It may be appropriate to evaluate, discuss or assess the alignment between organization values and organization policies, procedures, funders, programs and activities. Plan a frequent evaluation and reconnection to organization values.

Remember, when all needs are on the table (values are needs) this creates the place of greatest possibility. This applies internally, organizationally and in our community. If everyone can identify, communicate and connect with our common values and needs we will create the greatest list of possibilities to accomplish our vision, mission and outcomes. Identifying our own values and those of the organization is a necessary ingredient to develop healthy boundaries and avoid blaming and other negative strategies.

## **Vision creation or reconnection**

Read this section for ideas. The ultimate decision to make, assuming you have decided to develop a watershed vision or a vision to provide context for your monitoring and assessment activities, is what process you will employ with what people to develop this watershed vision.

What do you want your watershed to look like, how do you want the organisms in it to behave? This may involve modifying an existing mission, reconnecting with an existing vision, scraping the old and starting new, or starting from scratch. Review the process of brainstorming provided in the *Step 1 Resource Guide* to understand that it is a process of creating without judgment followed by assessment and then choice. For every value listed, brainstorm words that expand upon that value.

### *VISIONING IN CONTEXT WITH SYSTEMS THINKING FOR SUSTAINABILITY*

We have all witnessed or heard of the many critical issues facing the human community today, many of which have not changed much the past few decades. Far from abating, oil and gas drilling, deforestation, biological dilution and eradication of fresh and salt water fisheries, increased ground water, air and non-point source stream pollution – to just name a few. The social arena is the similar, war, poverty, increasing prison populations, struggling education systems, disease and the unraveling of civil society. Most of these problems have not only persisted but have intensified, despite and sometimes because of innumerable policies and programs intended to resolve them. We have written thousands of laws and allocated trillions of dollars to prevention, intervention and remediation, and yet we are, in many ways, further than ever from world peace, a sustainable country and world economy and a cleaner, healthy global environment.

Why is this so? It could be argued that these problems are caused by the ways we think, learn and communicate. Our ways of thinking determine the kind of political, economic and social structures we build, and those, in turn, create the patterns of events we see in the world, study in our classrooms and employ in our work place and community. If we want to change those events, we must change the structures that create them, which means we must learn to change the way we think, and to communicate that learning effectively. The only real change each of us can do and is responsible for is changing ourselves. If each of us learns new ways to connect with ourselves first and others next, change will manifest through new structures in our environment and community.

We can discover measure, identify and emphasize facts, figures and trends. However, just telling people how bad it is - is not enough motivation for them to change. Most already knew the bad news. If they didn't the announcement of potential calamity not only failed to motivate them, but it often drove them into denial or despair. It is difficult to knowing so much about the state of the world as trainers, educators and professionals working in the field. And some of us work with young people who also know too much, and are fearful of their future. Sobered by this, the emphasis on personal and structural solutions and the actions each of us can take to implement those seems more appropriate and effective.

A striking recognition in this “knowing too much” is that most of us are also already aware of the solutions. Many of you have conducted exercises that involve posing a situation or issue, then the activity is incorporates role playing, investigation, etc. to problem solve the issue. In so many cases,

people tend to choose meritocracy where they design a sustainable community aimed at maximizing the needs of most community members.

The hard question is that if we recognize not only the problems, but also the solutions, why don't we create a just, secure and sustainable world? The easy answer is to blame someone else, often government or corporations, or to put it down to political, structural or economic roadblocks. But the real roadblocks are not material. They are mental, cultural and educational. Belief underlies behavior, we employ our beliefs to get our needs met, and all of the things we do or don't do are shaped by the ideas we hold about how the world works or should work--by our worldview.

*WINDOWS INTO OUR WORLDVIEW, WHAT IS A WORLDVIEW?*

It is a collection of assumptions, which we believe are self-evident truths that both interpret our past and, to a great extent, determine our future. Since our worldview is our built-in "operating system", we are not even aware that our ideas and actions are filtered through it. In fact, a worldview could be described as mental environment that is to humans what water is to a fish – the stuff we swim around in every day and do not even recognize.

If we explore the dominant worldview (which might once have been called the "western" worldview, but which now has spread across virtually all borders and cultures with the adoption of western economic models) we encounter certain key assumptions:

- ◆ That constant and unlimited growth is not only possible, but essential
- ◆ That humans have dominion over the Earth
- ◆ That nature is income – resources are free because we "found" them
- ◆ That if we destroy our environment, we can simply move west (or into some other part of the world) or invent some new technology to save us
- ◆ That we can understand the natural world through reductionism, by breaking it down into small parts
- ◆ Every action has an associated cost, but because the costs may not be tangible, immediate, evident or within my world, there is no need to take responsibility for the action, someone else is taking care of it.

It is beneficial to explore these assumptions with ourselves, families, students, organizations and communities. Look closely to see if (and how) they are manifested in curriculum, history, media, policy, dialogues. For instance, how are our scientific models "reductionist" in their worldview? Is 'smart growth' a component of local land use planning? How do accounting practices discount or ignore (externalize) environmental impacts? How do we attempt to manifest our "dominion" over the Earth, to control or defeat nature through interrupting or controlling natural processes? How often do you hear we will deal with growth and resource consumption by colonizing space, improving drilling technology or automobile efficiency?

As we examine the assumptions of the dominant world view, we see that it is an open system view. It assumes a world without limits, a world of unlimited land, resources and human knowledge and wisdom. To be fair, it has served us reasonably well for thousands of years (as long as we were willing and able to tolerate wars, famines, plagues, environmental destructions, slavery and genocide). Today,

however, it is clearly obsolete and increasingly dangerous view. The only biological model for unlimited growth, after all, is a cancer cell, which ultimately kills its host. Humans are only a small part of the Earth, entirely dependent upon it, and most certainly not in control of it. Nature is an endowment---a savings account, if you will -- and when it is gone, so are we. Quality of life will chronically erode, it disappears too when quantity is gone. While reductionism can reveal some valuable insights, it cannot explain how a spider knows geometry or a microscopic seed carries within it both the genetic blueprint and the commitment to create new life.

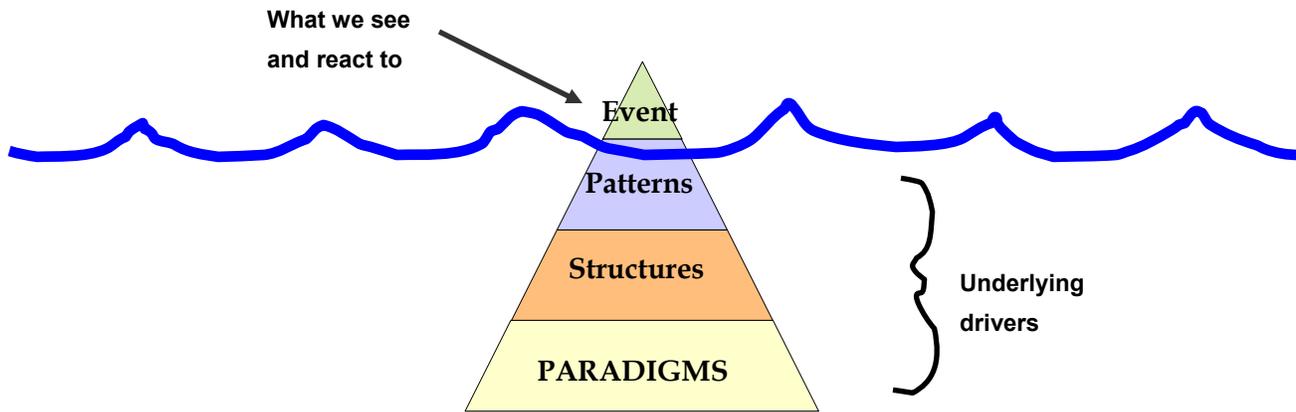
We continue to cling to our worldview, in our moments of despair and hope, and continue to act out of it. When things don't work, we do them harder, longer, throw more money, time or people at it. We are like the fabled tourist abroad, who, upon discovering that the natives don't speak his language, simply repeats himself at a higher and higher volume. We don't do this because we are evil, fundamentally flawed, excessively greedy or terminally stupid. We're doing it because we are loyal to our culture, and because our culture rewards and reinforces this behavior. The purpose of culture after all is to preserve itself. So, we are acting out of our own evolutionary mandate.

For almost all of human history, we lived in small groups in local ecosystems and had to think only in very short time frames ("we need to find food" or "watch out for that cave bear"). Thus we evolved to relate to and care about small numbers of people, to pay attention only to our immediate surroundings, and to be concerned only about short-term events and trends. All of this made sense for the first two or three million years of human existence, but it has become a tremendous handicap in today's world of six plus billion people, global warming, bio-terrorism, and toxic wastes with half-lives measured in millennia and grocery bags that take ¼ or more of our life time to decay.

The game has changed and the planet is changing, in large part due to the success of our species, and we must learn to change with it, in response to it. We must not only change our actions, we must change our way of thinking, because as Einstein observed, "We can't solve problems by using the same level of thinking we used to create them".

#### *TEACHING FOR THE FUTURE*

If the ways of thinking got us to this point are inadequate for the future, how do we consciously learn to think in new ways? And how do we communicate, or teach, that learning? It begins with understanding the nature of the problem. System thinkers sometimes use an "iceberg" model, so named because the tip of the iceberg---the ten percent we see above the surface -- are events. These are what we see on the news or read about in the paper. But if we look beneath the surface, we can see that these events are part of larger patterns. If we look even further below the surface, we can see that structures -- political, economic and social -- create these patterns. And if we look all the way down to the base of the iceberg---to the great mass upon which the currents push to determine the berg's movement -- we see paradigms or belief systems. These are the beliefs we hold about how the world works and that generate the kinds of structures that create the patterns of events we so often find appalling or in conflict with our values.



Paradigms, also called mental models, are not only assumptions about how things are; they are also a commitment to making things that way. They lead us to treat our assumptions as facts, and since they profoundly influence the results we get from our actions, they are self-reinforcing. We don't have to look very far for an example of how our mental models generate unintended negative outcomes. Brain research tells us that adolescents do not learn very well early in the day. But we persist in scheduling early classes because we hold the mental model that we need to maximize bus efficiency to save money, and (less often acknowledged) that we must warehouse children during parents' working hours. If instead we held the model that schools are to maximize learning and fulfillment for our children, we would organize them quite differently and solve the transport and babysitting issues in new and more creative ways.

There are simple and non-threatening ways to challenge our own mental models and those of who we are choosing to work with and for. *The Systems Thinking Playbook*, by Dennis Meadows and Linda Booth Sweeney, offers a number of quick little exercises called "mind grooving" that can help us see how our own mental models operate. Here is one for example:

**Word Association:**

*This exercise is a simple word association game. Words are spoken in sequence and students write down the first word that pops into their minds. The sequence is: a color, a piece of furniture, a flower. Ask students to write down their words and then ask for a show of hands. How many people said, "red?" How many people said, "chair?" How many said, "rose?". How many people said, "blue?" How many people said, "couch?" How many said, "daisy?" How many said some combination of the above: red or blue, chair or couch, rose or daisy?*

*In audiences ranging from fewer than a dozen to hundreds, typically ¾ or more will say 'red, chair, rose' or 'blue, couch, daisy', or some combination. Now, how could this happen? After all, we North Americans like to think we are the most individualistic people on the planet. This exercise is a simple demonstration of how strong our socialization and enculturation are. A biologist would say our neural networks are operating---that we have learned to think in particular ways and, like wagon wheels in a rut, we follow those tracks. In short, we can see only what our mental models allow us to see.*

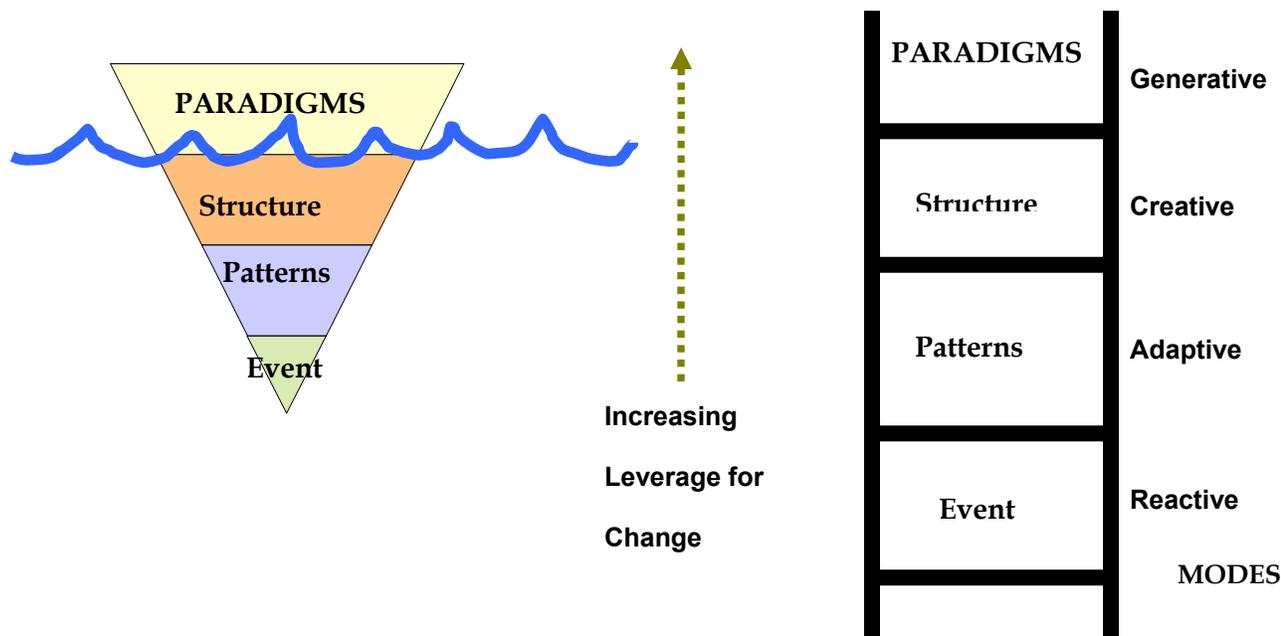
*If some students or participants say something completely different, "purple, table, lupine," for example – grab them. They see the world differently. They are not constrained by our mental models, and*

*they can see and help us see differently, too. If folks feel like it is a guessing game it may not work, coach them to respond naturally.*

**Thumb Wrestling:**

*Another favorite is a variation on the childhood game of thumb wrestling. This is a simple game in which the instructor pairs off the participants and has them lock their right hands together with thumbs up. On the command "GO" each player attempts to "pin" the other's thumb with his or her own. We offer a prize for the most pins, and then time a 60-second bout, after which we ask how many pins were achieved. Typical responses are two, three or four. But someone is likely to have 50 or more. When we explore how this could be, we find that the opponents agreed to become partners to achieve the goal of winning the prize. One pinned the other repeatedly to collect the most pins, then shared the prize. In this case, the mental model of competition (win-lose) guarantees failure, while the new model of collaboration (win-win) assures success.*

While mental models can trap us in dangerous ways (consider that there are over 30,000 nuclear weapons in the world, based on the "peace through strength" paradigm) they can also be very powerful agents for positive change. Remember the iceberg? Since it tells us where the most powerful leverage points are, we can turn it upside down to create a "**ladder of influence**" which looks like this:



***Paradigm or Shared Vision (Generative Mode)***

The paradigmatic or shared vision level is the most powerful leverage point for change. When we hold a conscious vision of the results we desire, that vision shapes everything else. This may take generations or large numbers to sustain. Those that try and create change from this place are often said to be “before their time” or “crazy”. If one is reacting and not questioning the beliefs underlying the event that triggered the reaction, one won’t, at first, comprehend the power behind a shared vision.

***Systemic Structure (Creative Mode)***

We generate structures in response to our shared visions and paradigms, conscious or unconscious. They are the means to the end we envision, and they, in turn, create the patterns of events we see and experience.

***Patterns on Events (Adaptive Mode)***

At this level we can see the behavior our systems create over time, which can help us break out of our short-term thinking. This is a learning level, a signal a potential wake up call. We can choose to adapt to the pattern and keep asking the question why it never seems to change or sustain change or look at the underlying beliefs and paradigms and leverage change from there.

***Events (Reactive Mode)***

The event level is purely a reactive one. At this level, all we can do is act in response to the events, not change the pattern of events, much less the structure that spawns them. We can see that if we want to create or manage change, we have to do so at the generative level, not a

reactive one. If the goal of a system (the vision) changes, the results it generates will change too. *If we want different outcomes, we have to hold different visions.* We also have to remember that, as Zen teaches, “no action is an action.” The lack of a positive vision engenders a chaotic or opportunistic system that can spiral off and create severely negative outcomes. Or as songwriter Bruce Coburn put it, “In the absence of a vision there are nightmares.”

One powerful foil to random and opportunistic systems is the art and practice of systems thinking. In fact, it could be argued that this may be the single most effective tool currently available to better understand the world we live in and to create a sustainable future.

### Systems Thinking

Systems thinking is simply a perspective, a language, and a set of tools for describing and understanding the forces and interrelationships that shape the behavior of a system. A system is defined as a collection of parts that interact to function as a whole and continually affect each other over time. Systems are not only interconnected, they are coherently organized around some purpose. Examples of systems include families, a soccer team and an airplane. Systems also have “emergent” properties not found in their separate parts. When the parts are organized into a system, they create new properties, characteristics and behaviors.

We want your watershed assessments to be information systems, not a set of independent, unconnected activities. System thinkers can be identified by certain characteristics which they share. System thinkers:

- ✓ Think long term
- ✓ See the big picture
- ✓ Focus on structure, not on blame
- ✓ Look for interdependence and cause and effect relationships
- ✓ Change perspectives to see new leveraging points
- ✓ Consider how mental models determine our future
- ✓ Hold the tension of paradox and controversy without feeling the need to resolve them quickly

If we compare systems thinking to traditional mechanistic thinking, we can see significant differences

| <b>Mechanistic Thinking Sees:</b> | <b>System Thinking Sees:</b> |
|-----------------------------------|------------------------------|
| Parts                             | Wholes                       |
| Objects                           | Relationships                |
| Events                            | Structures                   |
| Isolation                         | Interdependence              |
| Specificity                       | Generality                   |
| Statics                           | Dynamics                     |
| Simplicity                        | Complexity                   |

There are simple exercises to illustrate the difference to others. One utilizes small groups. Collaboratively each group brainstorms and diagrams all the products, processes and impacts associated with seemingly simple things in their daily lives, their house, transportation, favorite food, possessions, an article of clothing and favorite hobby or activity. It demonstrates how everything is interconnected and it offers an expanding systems perspective as one can see the individual parts as a component of a larger whole, objects within larger relationships and the complexity that underlies seeming simplicity.

#### *CREATING A VISION*

There is a science fiction story about a man who builds a time machine to visit the future. When he comes back to the present he tells people what he saw there. "It's beautiful," he says. "People are peaceful, healthy, creative and fulfilled. The earth is pristine, poverty and disease have been defeated, art and music flourish."

Inspired by this vision of the future, people set off to create it, and they succeed. On his deathbed, the time traveler makes a confession. He never built a time machine and never visited the future. It was simply a vision of the future he hoped for. And it inspired and empowered people to create that future.

If shared vision is the most powerful leverage point for change, how do we go about forging it? Visioning is not something that comes easily for most of us. Perhaps because of that evolutionary upbringing that keeps us in mental models in which we find visioning impossible to do. The good news is that visioning can be learned and taught.

#### *Idea 1:*

Here is an exercise that might help:

*Imagine it is 2050, and you are still here. Close your eyes, breathe deeply for a moment, and imagine what the world looks like and how it got that way.*

Your first responses might be negative, all the trees are gone, the water polluted, etc. Many times these negative visions are our deepest fears for the future and in them lay the juice for the fodder. It is perfectly okay to have negative visions. One way to visualize what we want is to be clear about what we don't want. Thus, we can turn negative visions ever so gently toward the positive—to express not what we fear the future will be like but what we want it to be like, what we wish for our own children and for their children. Things begin to change when we do this. If we can express and get in touch with our greatest hopes, our deepest faith, our most powerful desires for the Earth, our compassion, courage and love, a picture of a very different, very positive and very possible future emerges. We manifest what we see and if what we see stays rooted in our fear versus our hearts the systems we build will not serve our heart or others either.

We would like to suggest that our every individual action and reaction is based upon a need, want, hope or values. This holds true for an organization. An organization is not organic; it is made up of people, even if its systems are designed to achieve outcomes through an organic structure and function. And thus, organizations, through the collective vision, mission, function and system acts and reacts based upon its needs, wants, hopes and or values. When needs, wants, hopes, or values align the result

is synergistic. When differences between needs, wants, hopes or values are heard and respected, synergy can still be a result as long as there is enough common ground.

Holding a positive vision of the future is much like planting a tree that takes many years to bear fruit. When you plant the seedling, you are undertaking an act of faith. You believe there will be a future. You are consciously choosing to do something, not for yourself, but for your grandchildren. You have to have the vision of that child sitting in the shade eating the fruit from the tree. You have to have courage to believe in the future, the clarity to see that long view, and the commitment to see it through—not to cut it down for firewood to stay warm one night.

Again, there are many ways to create a vision, none are right, none are wrong. The vision will vary among groups with content, timeline, scale and goals. The following is another example that employs critical thinking. It can serve as a template for problem solving and implementing change in local or global scale such as a work team, school, community or planet.

*Idea 2:*

**Global Vision:** Determine how to split the group in smaller groups if necessary. Ask one (or several) group to describe what the world will look like in 20 years. Have the other group(s) describe what they want the world to look like in 20 years. Or, have each do both. This can be captured collective brainstorming, individual free writing, or another mechanism. Help both groups by suggesting they address specific human needs and quality of life issues, including food, water, shelter, energy, work, transportation, education, peace and the environment, security and governance. The group that is describing what

If we are angry about our situation we have the opportunity to realize that anger has a life-serving core. Anger is not an undesirable quality needing to be purged. The object is to find the juice in our anger and harness it. To not ignore, squash or swallow the anger but rather to express the core of our anger fully and wholeheartedly. First, we divorce the person/situation/circumstances from any responsibility for our anger.

When we are confronted with an message or behavior we don't like, we have 4 choices 1) we can blame ourselves, 2) we can blame others, 3) we can get in touch with what needs we have that are not being met and 4) we can get in touch with what needs others have that are not being met.

Anger is generated when we select option 2—whenever we are angry we are finding fault—we blame others for being wrong or deserving of some punishment. This is the cause of anger, the way we are thinking, in terms of blame, judgment and punishment. Another choice might be rather than go to our head to make a mental analysis of wrongness regarding somebody; we choose to connect to the life that is within us. This life energy is most palpable and accessible when we focus on what we need in each moment.

For example if someone arrives late for an appointment and we need reassurance that she cared about us, we may feel hurt. If, instead, our need is to spend time purposefully and constructively, we may be frustrated. If, on the other hand, our need is for thirty minutes of quiet solitude, we may be grateful for her tardiness and not at all angry. Thus, it is not the behavior of the other person, but our own need causing our feeling. And when we are connected to our needs we are in touch with our life energy and that is where possibilities lie. Anger is a result of life-alienating thinking that is disconnected from needs. It indicates that we have moved up to our head to analyze and judge somebody rather than focus on what we need and are not getting. If we choose the 4th option, we connect with what the other person is needs and thus anger is not a result either.

they want needs to phrase their descriptions in the positive, so for example instead of saying, "We won't use polluting fossil fuels", say, "In the future, we'll use only clean, renewable energy."

Individuals and small groups share the most important elements of their vision and the group makes a master list. You may need or want to lump some items. Next, divide into groups and assign each group a topic from the master list.

*Idea 3:*

**Local Vision:** Alternatively, break this exercise down into much smaller pieces and short timeframes (WS < ORG < Etc.) that folks students will be able to more easily imagine and monitor. A good example might be to ask them to visualize how they would like their school to work in order to maximize learning, safety, and happiness, and to minimize environmental impacts. Components might be scheduling.

*Idea 4:*

**Focus Vision:** A small group of folks pre-create 8 scenarios that present different faces of the future. Choosing the best scenario is not important; the purpose of the exercise is the discussion itself. Need larger blackboard or chart paper and done set of 8 scenarios for each group of 3-5 members. Distribute a set of scenario strips and one extra blank strip to each group.

1. Ask them to read the scenarios and discuss them within their group. If they think a possible scenario is missing they can employ the blank strip.
2. On the board or chart paper, draw two diamonds side by side. Within each diamond draw lines to create nine boxes, as shown below. Label the first diagram preferences and the second probabilities.
3. Ask ½ the groups to rank the future scenarios according to their preference. Place the most desirable on the top row, second and third on the second row, and so forth with the least desirable on the bottom. Ask the other groups to rank scenarios according to what they think is probable, marking the most probable future scenario in the top row, second and third most probable on the second row and so forth with the least probable scenario on the bottom.
4. Ask the groups to read their choices out loud. You can write each group on the blackboard or do series of shares and have "group" consensus.
5. Begin a debriefing by reading scenarios for both preferences and probabilities in the same rows. Discuss why it is preferable and probable future. Questions might include, "have you read anything that suggest this?", "heard any scientific evidence to support?", "why is this good/bad?" If no preferable and probable scenarios are placed on the same level, discuss why this is the case. Ask, "what would we need to do to make the most preferable the most probable?", "what can we do to make this change?" You can assist this discussion with providing information, readings and the like for the scenarios. The future is not given; we make the future through our choices. It is up to us to decide how to amend the troubles, celebrate the successes or resign ourselves to them.

**Example of Watershed Visions:**

"By the Year 2020, the waters will be safe for all forms of water-based recreation, watershed residents will be free from water-borne pathogens, and the watershed ecosystem will support self-sustaining communities of water-related native plants and animals."

"Protecting water quality within the entire watershed while balancing competing demands for use of land and water."

"Maintain and protect high quality waters."

"Maintain and protect existing uses and water quality."

Today, our worldview, our story, no longer tells us of our place in the world or provides a context in which to root our communities. In short, it is inadequate to explain the times in which we live. Perhaps that is why many seem lost, why they pursue addictions or gluttony, why violent crime and prison populations in the US are magnitudes larger than any other country. Teaching for the future is really about changing the way we think, learn and communicate. It is about creating, telling and teaching new stories to each other. These must be stories of compassion and community, faith and spirit, celebrations and love. Stories of a just, sustainable and joyous future, and stories not only of, but in concert with, the beauty and wonder of the Earth.

Any process of change is a complex system. It is goal-driven, interactive, and has both positive and negative feedback loops built in. It's even self-organizing. But it won't operate in a vacuum. It needs a vision to drive it. <sup>1</sup>

Whatever the result, put your watershed vision in writing. Illustrate it if that is helpful. The watershed vision should have a delineated boundary and scope. In addition, have a plan to share the vision. Place it on all organizational material and media.

### **Delineate the watershed boundary that serves the watershed vision**

Using topo maps or hand drawn maps, visually delineate the physical watershed boundary or boundaries that serve the watershed vision. The physical watershed boundary maybe a subwatershed or smaller system. It maybe a subset of a large system like the Colorado River. If there are water diversions that move water into our out of your physical watershed boundary, perhaps you should include the source or receiving watersheds. It is important to define the watershed boundary physically.

### **Sharing the Vision**

So, what is your vision? You can share the process of defining it or define it alone. Your passion in communicating and sharing this vision will be what motivates others to join your journey in making the vision come true.

We can instill the power of visioning into others by:

- ✓ Becoming visionary ourselves-by creating, sharing and calling into being visions of a just, humane and beautiful world. By stimulating imagination, because we have to imagine what

may seem impossible right now. By challenging and inspiring and fostering the best in ourselves and in our circle of influence.

- ✓ Including our vision on our written and electronic materials, in employee and volunteer orientations, in our speeches and communication, and as a conscious foundation for all decisions.
- ✓ By building community-by networking, by engaging with others in creative and constructive actions to help call into being and move toward that shared vision.
- ✓ By modeling the skills we want to see in our community, demonstrating courage, clarity, truth-telling, commitment and adaptability in our lives.
- ✓ Being story tellers. For almost all of human history, stories were the way we learned, shared experience, transmitted wisdom and built community

### Identifying Vision Outcomes or Results

Now we have a vision or view of what is possible and it aligns with our organizational values so it has fuel. Human nature calls for us to create expectations around our vision. We do what we do because we have expectations that something will or will not happen as a result. Expectations help us define outcomes, results or indicators that help us measure progress toward our vision. This is important if a vision may take 20, 50 plus years to fully manifest. Expectations help identify specific results that would indicate the vision is manifesting.

In order to evaluate success, it is essential the desired results are identified before the list of activities and target audiences. We need to know where we want to end up before we decide how to get there.

We want to place premiums, the amount of investment, on the right outcomes.

These outcomes are used to determine what activities we will do for what target audiences.

Review the process of brainstorming provided in the *Step 1 Resource Guide* to understand that it is a process of creating without judgment followed by assessment and then choice. Try and conduct this activity above and beyond what activities your organization is currently doing or not doing. *Diverge*. Brainstorm all the results or outcomes that would demonstrate or indicate that your vision is achieved or making progress. Outcomes are statements about how conditions will

#### About Reference Conditions

Reference Conditions typically describe conditions that are only minimally affected by human activities and/or major natural disturbances. Reference conditions can be actual conditions found and measured at real locations (known as "reference sites") that are relatively undisturbed. Or they can be theoretical conditions that describe goals for the waters based on scientific theory, summaries of data from similar waters, or risk analysis. A common example is state water quality standards. Reference conditions might also be some combination of actual and theoretical conditions. Reference conditions can be described in terms of maximum levels of specific pollutants (stressors) or in terms of the desired conditions of watershed processes, functions, and living communities. Phase 2 delves into this further.

#### For example;

In the context of watershed assessment, we suggest that you consider 4 types of outcomes:

1. **Increased understanding of water body conditions:** This involves people learning about their waters and how they work. Example: Watershed residents learn that many of the waters in their area do not support healthy aquatic life or water contact recreation.
2. **Changes in attitudes:** This involves people forming a different opinion or view of their waters based on learning and understanding. Example: *Watershed residents, organizations and agencies are motivated to make a plan to take action to restore watershed health.*
3. **Changes in behavior:** These are decisions or actions taken voluntarily or through regulation, to protect and restore waters. Example: *A restoration plan is put into action which specifies actions to be taken by individuals, businesses, and agencies. People carry out "best management practices" to reduce their impacts on their waters.*
4. **Changes in the condition of the water body (restoration or protection):** This involves measuring actual change (expected result of restoration) or continued high quality (expected result of protection). These changes are typically measured by comparisons to *reference conditions*, a set of benchmarks that describe the water quality need to achieve these desired outcomes. Example: *All waters support their designated uses.*

*Converge.* Explore. Research. Ask questions. Consider. Weigh. Discuss. Assumptions. External Factors. Resource audit. Impact. Narrow with hits or some process.

*Emerge.* Choose. Identifying what outcomes, results or piece(s) of the watershed vision your organization chooses to achieve or influence, that align with organizational values.

### **Identifying Vision Outcome Outputs (Activities and Target Audiences)**

Now you have a list of possible results, desired changes or outcomes to measure progress toward your vision. Next step is to brainstorm, diverge, converge and emerge all possible outputs for each outcome. Outputs are the activities and associated audiences, the things you can do (not will do yet) and who they are meant for in order to achieve the outcome. Thus, every activity listed must have at least one associated target audience.

For monitoring and assessment activities, usually the target audience is a decision maker. A decision maker is anyone who might use the information to make a decision. The decision can be a change in behavior from increased awareness or can be the closure of a waste water treatment plant. Decision makers range from informal to formal, from you, your neighbor, and community to the regulator and legal processes and individuals.

*Diverge.* Possible ways you might achieve each outcome or result. What activities, tools, strategies and mechanisms would you, could you employ. For each activity or mechanism what is the target audience(s) you are reaching with the mechanism. Activities and audiences are outputs designed to achieve the specific outcome. Some activities and audiences might apply to multiple outcome(s), that is leveraging.

*Converge.* Explore. Research. Ask questions. Consider. Weigh. Discuss. Assumptions. External Factors. Resource audit. Impact. Narrow with hits or some process to get general agreement or consensus.

*Emerge.* At this point, whether or not you can or will do everything you list is not relevant yet, it is important to note all the possibilities and then choose what you will commit to. This step can be overwhelming at the end with lots of information, issues and concerns raised. It does not mean you will be dealing with everything you discover. Based upon your current general interest or questions start with these questions. *Here we will narrow the focus to watershed assessment monitoring activities. You may, or should, come back to this list, flesh out and evaluate another activities your organization, may undertake.*

### **Identify Outcomes and Outputs that involved monitoring and assessment**

You have generated a master list of possibilities to manifest your watershed vision, desired outcomes and list of activities and audiences to achieve results. It is not likely that you or your organization can do it all, or at least right now. This list should include monitoring activities as well as other type of activities. We are now going to focus on the developing an effective and accountable watershed assessment and monitoring design that came from your vision. From the list of outcomes and outputs, identify all outputs and outcomes that might involve monitoring. If you find this difficult at this point, it will be a challenge to get more specific later. If you want a general overview of monitoring and assessment introduction or planning, try the first two-three chapters of the *Draft, California Watershed Assessment Manual*<sup>7</sup>. This is not a “how to” guide but might get you thinking.

Let’s explore those. A version of converging. Write a sentence or two describing the monitoring and or assessment. Try and weed out what monitoring activities, purposes or information you might be generating with the output or for the outcome. You need to have a sense of each monitoring activity.

### **Produce a list of possible decision-makers to influence and the decision(s) they make for each paired outcome(s) / output(s) related to monitoring and assessment**

From this monitoring activity list, we want to, diverge, converge and emerge around possible decision-makers for each monitoring activity. We need to refine the target audience for further steps. This is an essential component and exercise for an effective and accountable monitoring design. If we don’t know who we are targeting and why how will we know if we succeed? We also need to know what decision they will make, for planning and evaluation. Further, if we don’t understand the information each decision-maker needs to make the decision we desire, how can we the information to them? Isn’t that like shooting squirrels in the dark? We may get one, but we don’t know when or if we will. We address this last point in Step 5.

For each monitoring activity, *diverge*, brainstorm all the **possible decision-makers** that might use information the monitoring activity will generate. For every decision-maker on the list include **what decision you desire** them to make. At this point we will not converge or emerge yet. We will essentially do that in the next steps.

**For example**, Monitoring existing conditions for use support:

Decision maker – Decision

State Health Department – determine if use met or not

**For example**, Monitoring a treatment or best management practice for effectiveness:

Decision maker – Decision

Local conservation district who installed practice – determine if decreased sediment load to creek or not

**For example,** Monitoring to see if source of bacteria is overgrazing

Decision maker – Decision

Land owners in stretch – change ranging practices, implement BMP's if source is from their practices

State Department of Agriculture – help develop and implement BMP's for ranchers in small operations (less than 40 head)

### **Employ the Logic Model to communicate, plan and evaluate**

The primary purpose of this entire step is to converge and emerge our inventory and visioning steps into a format we can plan efficient and effective watershed assessment monitoring. We need a tool or a visual aid to help us organize our inventory, vision, outcomes, outputs and associated monitoring activities. Something that keeps them connected and aligned in both structure and function.

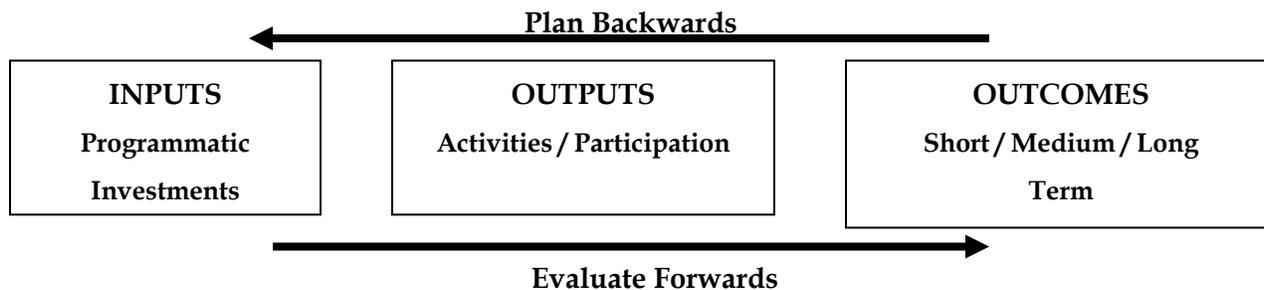
We will use the Logic Model to keep the monitoring activities for our watershed assessment connected to our vision and inventory. We will also use it to expand upon each monitoring activity as we design our watershed assessment. You can use the Logic Model to expand all outputs, activities and audiences, not just monitoring. We will focus on monitoring activities in the context of watershed assessment the remainder of this framework. You will place your list outcomes and outputs generated that involve monitoring into the Logic Model. We will then work from this to provide more depth.

The Logic Model provides one such tool. The Logic Model was developed by the University of Wisconsin Cooperative Extension Unit as a tool to:

- ✓ connect what we do (outputs) with the impact we have (outcomes)
- ✓ provide a common vocabulary for both planning and evaluation
- ✓ Communication tool for funders, staff, constituents and public, graphic representation of the program “theory” and “action”, what is invested, what it does and what are the results?
- ✓ Format assists with focus on quality and continuous improvement versus outputs
- ✓ Keep inputs, assumptions and external factors that exist when outcomes and outputs are developed integrated in the evaluation process. The work is organic, assumptions, external factors and inputs will change, if for no other reason because of our success.

In this step we essentially take the work you already have done and put it into a logical format. This includes the vision, outcomes, outputs related to monitoring and assessment and list of associated decision makers and their decisions. The information captured is illustrated below, even though it doesn't have to look this way. The point is that it illustrates together, keep it visually connected and it might begin to function in connected manner.

Situation = WS Vision



With the Logic Model you describe the situation first, for us it is our watershed vision, second the desired outcomes, results or changes we want, third the outputs or activities we will do and the audiences we will reach. You plan with the end in mind and evaluate the outputs effectiveness in achieving outcomes. Finally you add the inputs, assumptions and external factors playing on the situation.

In illustration below the Logic Model displays all the necessary components. The situation, inputs, outputs, outcomes (short term, medium and long term), assumptions and external factors. The example provided below is the blank format. See how it connects the various components.

|                     |                            |               |                         |          |           |
|---------------------|----------------------------|---------------|-------------------------|----------|-----------|
| <b>Situation:</b>   |                            |               |                         |          |           |
| <b>Inputs</b>       | <b>Outputs</b>             |               | <b>Outcomes</b>         |          |           |
|                     | <b>Activities Audience</b> |               |                         |          |           |
| What we Invest      | What We do                 | Who we Target | Short Term              | Mid Term | Long Term |
|                     |                            |               |                         |          |           |
| <b>Assumptions:</b> |                            |               | <b>External Factors</b> |          |           |
|                     |                            |               |                         |          |           |

For examples see *Step 1 Resource Guide, including:*

- Page 1 is synopsis of the Logic Model
- Page 2 is a water quality context example
- Page 3 is the water quality context with evaluation questions and indicators listed
- Page 4 is a blank version of the Logic Model

You can utilize the power of the Logic Model in more detail and to capture all aspects of your watershed assessment. The “situation” you list on top provides the context. You will give this the first attempt by putting the work you have already done into this format. The situation or context is your

watershed vision. Place your outcomes in this model into short term (usually 1-5 years), medium term (5-10 years), and long term (10 plus years). Use time frames that make sense for you.

### **Identify assumptions, external factors and inputs for M & A outcomes/outputs**

Once you have your outcomes and outputs in place, list all the inputs, assumptions and external factors that apply to your outputs and outcomes. These they are essential for evaluation. If you evaluate your effort in five years, it maybe that the reason you are not moving forward is the inputs, assumptions or external factors have change but you have not incorporated that in your planning, evaluation or even identified them.

Inputs can be listed as items you already have or need. Assumptions include assumptions you make between inputs, outputs and outcomes. For example, you might assume that 10 hours of contact time teaching 5<sup>th</sup> and 6<sup>th</sup> graders about recycling will lead to adults recycling all types. The assumptions include the amount of necessary contact time and 5<sup>th</sup> and 6<sup>th</sup> grade is an entry point to change adult behavior. External factors include items outside of your immediate control that might explain an assumption, identified output or outcome. Items like decisions, funding (if not in your control), regulations, environments, legislation, and the like.

### Case Study 1

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### Case Study 2

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## References

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- <sup>1</sup> Modified, John Goekler, Green Teacher "Education for Planet Earth", Issue 70. Spring 2003. Page 9-14.
- <sup>2</sup> *The System Thinking Playbook*, Dennis Meadows and Linda Booth Sweeney, available from the publications manager, IPPSR, Thompson Hall Room G 01, University of New Hampshire, Durham, NH 03824 USA, 603.862.2244, [ippsr.games@unh.edu](mailto:ippsr.games@unh.edu).
- <sup>3</sup> *Visionaries: People and Ideas to Change Your Life*: Jay Walljasper and Jon Spayde, Minneapolis, MN: Utne Reader Books, 2001, ISBN 0865714452.
- <sup>4</sup> *The "Thinking" in Systems Thinking: Seven Essential Skills*, Barry Richmond, Williston, VT: Pegasus Communications, 2000.
- <sup>5</sup> *Forecasting Congress: Envisioning the Future*, Jan Cincera, Teacher at the Technical University of Liberec in the Czech, GREEN Teacher, Issue 72, fall 2003
- <sup>6</sup> *From Learners to Leaders: using creative problem solving in environmental projects*, David Bauer, David Hetherly and Susan Keller-Mathers, GREEN Teacher, Issue 72, Fall 2003
- <sup>7</sup> *California Watershed Assessment Manual Draft*, [http://cwam.ucdavis.edu/Manual\\_chapters.htm](http://cwam.ucdavis.edu/Manual_chapters.htm), Chapter 1 and 2.

## Resources

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*Contents in Phase 1, Step 1 Resource Guide:*

1. How to brainstorm, it is more than just generating a list, diverge, converge them emerge.
2. Logic Model four examples.

## RESOURCE GUIDE

### **Step 1: What Do You Know About Where You Are Going: A Watershed Vision**

#### **Contents**

1. How to brainstorm, it is more than just generating a list, diverge, converge them emerge.
2. Logic Model four examples.

#### **How to Brainstorm**

Brainstorming is one of many creative problem solving concepts and tools. Brainstorming is much more than generating a list of ideas, what you generate, how you generate as well as what and how you do something with that list is as important as the list itself.

Three important concepts, rules and tools of creative problem solving through brainstorming include divergence (idea generation), convergence (idea evaluation) and emergence (idea selection).

Divergence (exploring a topic) and convergence (selecting ideas) work together and are often referred to as the “heartbeat” of the creative process. Post rules of divergence and convergence around the room. If necessary, start with problems that are simple and fun. Within the process of implementing activities and projects to achieve desired outcomes we may need to diverge and converge several times, focusing into more depth on selected items, but employing the same tools, continually clarifying and generating ideas, until implementation. At this point we, doing the doing, become teachers, reaching out to others about the decisions and work being done. This is an iterative process and can be repeated.

***Divergence** is idea generation*, means to branch out, to explore the topic or task at hand in anew and exciting way and to open up thinking to the unlimited possibilities that exist. It is used to generate new ideas, options and possibilities. Divergence practice tools include:

- **Brainstorming:** The facilitator writes the topic on a large piece of paper, reviews the diverging rules with the group, and then writes down the ideas of the group’s members as they are generated. The facilitator leads and guides the brainstorming process but does not contribute ideas. A variation is brainstorming with post-its. Ideas are generated on a post-it, shared out loud and the facilitator sticks it on a chart. This allows for ideas to be re-arranged and lumped after all are generated.
- **Forced Connections:** This is a simple tool to use when the group is having difficulty thinking of new ideas while brainstorming. Forcing a relationship between the problem statement and an unrelated object can help get their thinking “unstuck” and guide it in a different and unusual direction. As the group is generating ideas, show them a toy, a picture, an object that is completely unrelated to the problem and ask, “What ideas can you get from this toy?” Give them time to generate ideas. If it slows again, use another object or picture.

The rules of divergence are:

1. Don’t judge ideas (wait until done and follow process)
2. Generate lots of ideas (at least 25)
3. Generate wild ideas (stretch!)
4. Build and improve upon ideas (expand and adapt)

**Convergence** is *idea evaluation* and involves bringing together divergent ideas, analyzing those ideas. A simple converging tool called Hits can be used when ever a group needs to evaluate information ideas an decide which are the key data or “hits” that is, items that are particularly interesting, that spark a new idea, or that are important to remember throughout the product. Hits can be made by individuals, but this is a great tool to use in groups as it provides an opportunity for participants to have equal input in selecting information or ideas.

To use hits in a group, hand out a number of colored sticky dots to each member (can used color markers too). Five dots to each member usually a good number, the more dots, the more selections members can make. Allow members to review their information then place their dots next to the statements they feel are most interesting, spark an idea or are particularly promising. After all dots are placed, you work with the items that have gotten the most “hits”.

Whatever process is used, the goal is to understand to whatever depth is appropriate, each idea generated. It is important to be inclusive in convergence. All ideas don’t need to go forth but need to be addressed in a manner that is respectful and inclusive.

The rules of convergence are:

1. Be positive (focus on affirmative judgment)
2. Have a goal (keep in mind the outcomes you want to achieve, have them visual)
3. Pay special attention to new ideas (particularly unique ideas) or those that you have strong reactions too (want to explore your reaction in relationship to your needs)

**Emergence** is *idea selection* and is about selecting the ideas that are most promising, what will you select and focus on? This narrows it down to the final few. It is a form of prioritizing. Some ideas may still be good, but it is not the right time. It might be the right time but your organization can’t do it. It can be fruitful to engage in expansion of the idea. Listing assumptions, external factors and resources/inputs necessary to accomplish can be helpful. What ideas align with the organization’s values, with a watershed vision, with your personal values? Select and take those selections through the next phase.

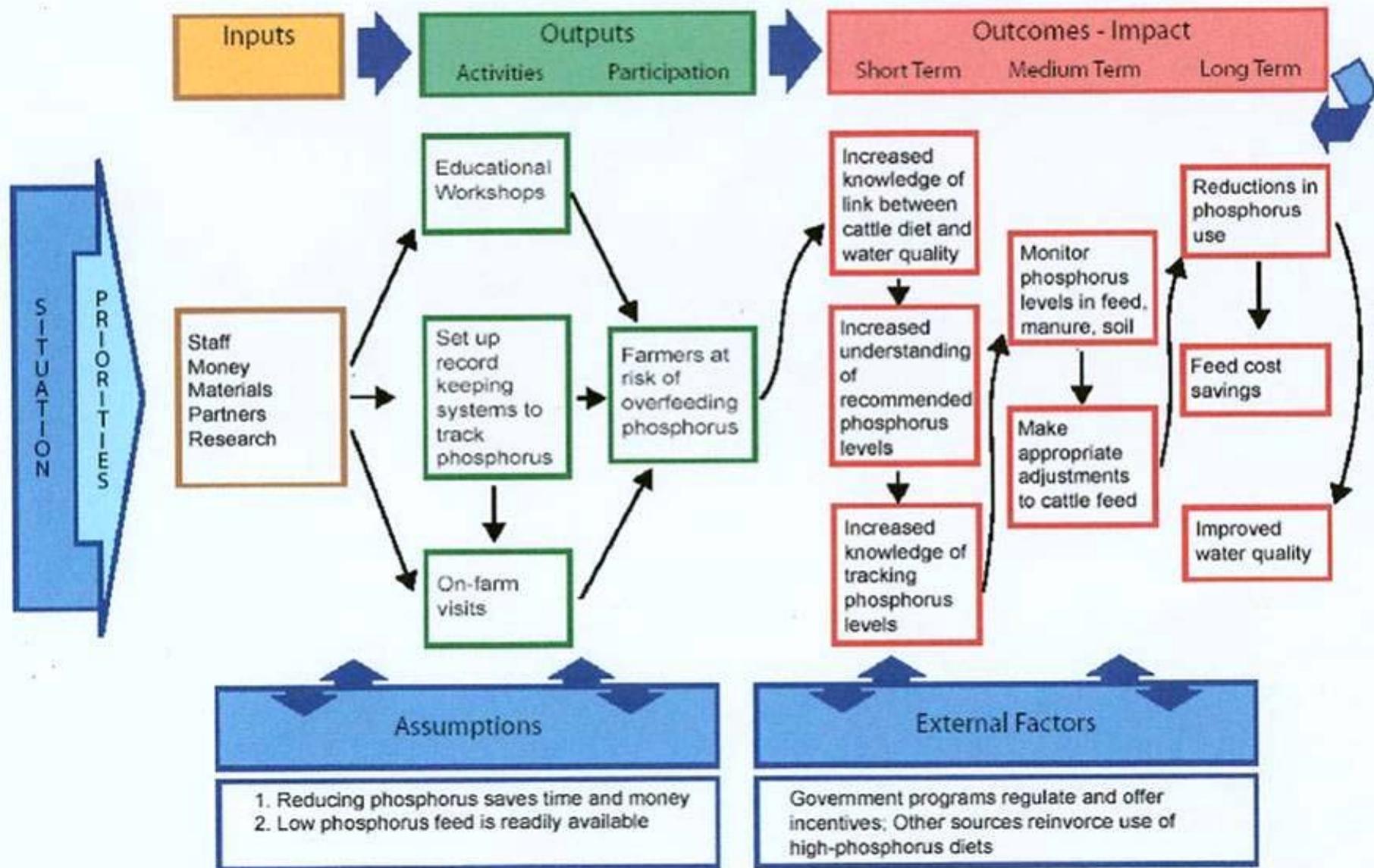
### Logic Model Examples

- Page 1 is synopsis of the Logic Model
- Page 2 is a water quality context example
- Page 3 is the water quality context with evaluation questions and indicators listed
- Page 4 is a blank version of the Logic Model

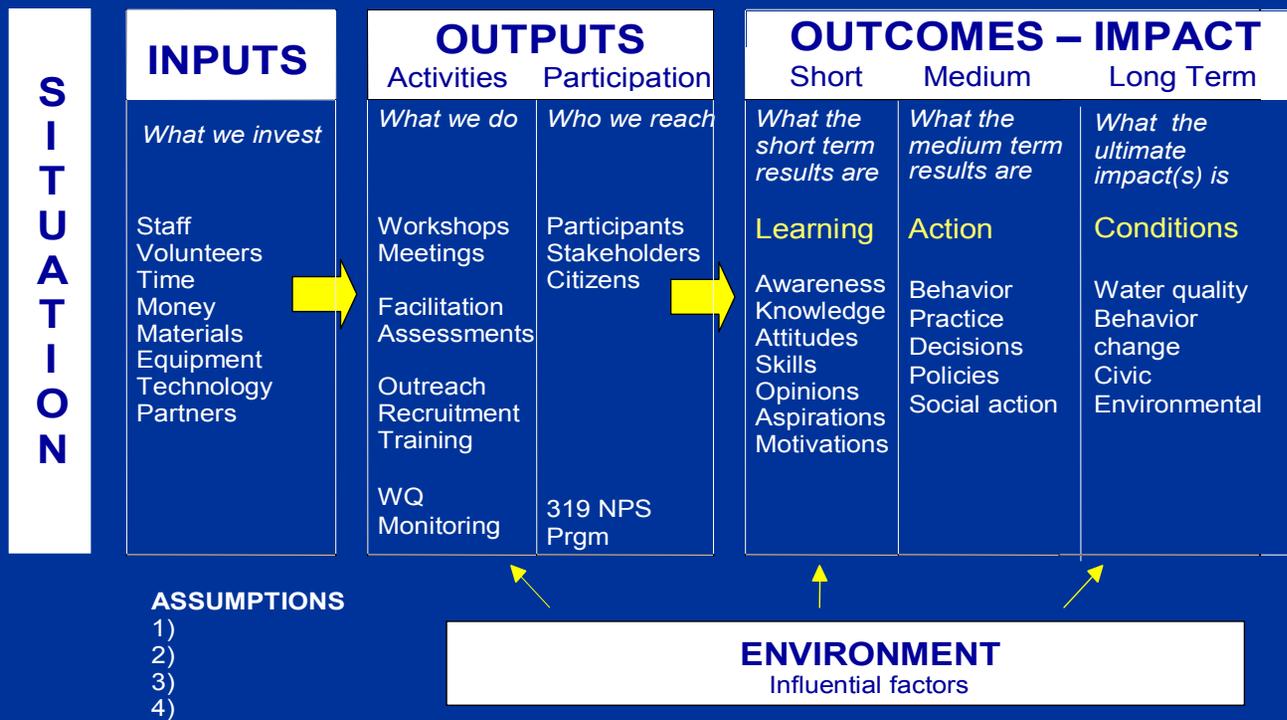




## Logic Model: Water Quality Program

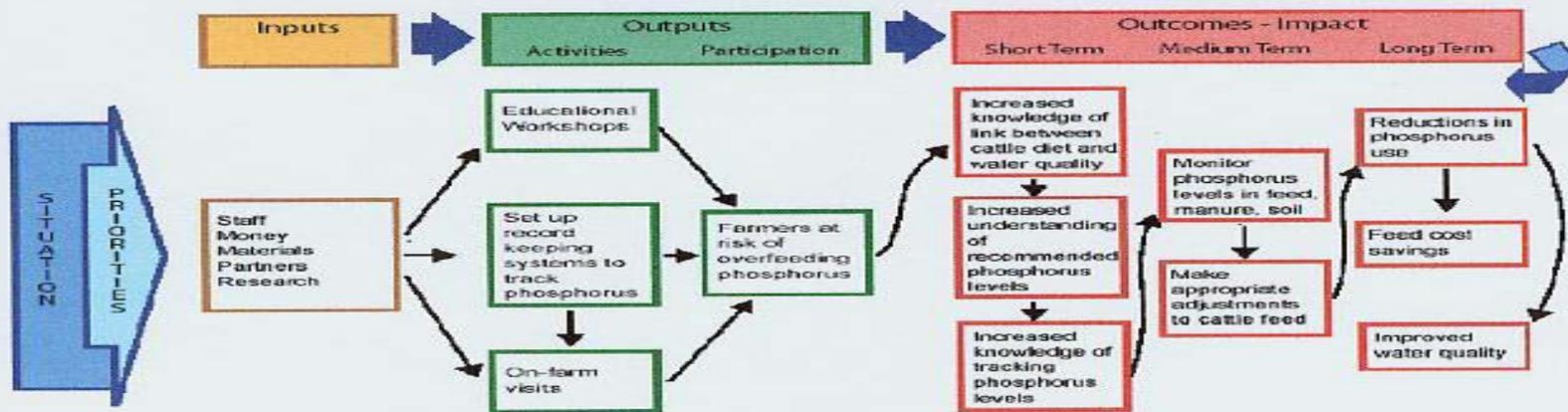


## LOGIC MODEL: Program Performance Framework





### Water Quality Program: Logic model, evaluation questions, indicators



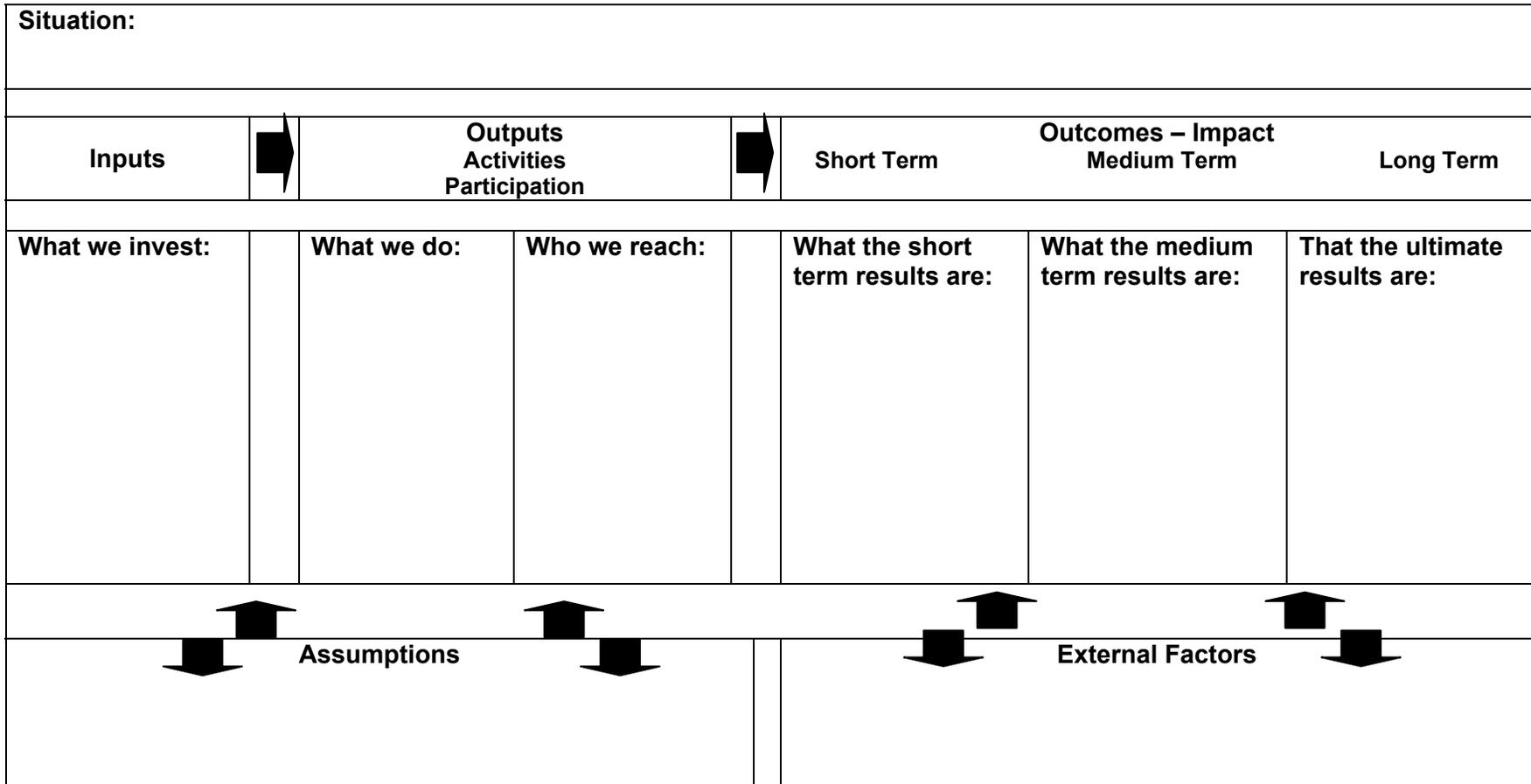
#### Evaluation Questions: What do you want to know?

|  |  |   |   |   |  |
|--|--|---|---|---|--|
| <p><b>Were the inputs sufficient, timely? Did they meet the program goals? Were they sufficient given the situation?</b></p> | <p><b>Did all activities occur as intended? Quality of intervention: appropriate content; usable record keeping system; well planned visits?</b></p> | <p><b>Did the targeted farmers participate? Who did not? What were their reactions? Who else was reached?</b></p> | <p><b>Did knowledge increase? Did understanding of P levels increase? What else happened?</b></p> | <p><b>Are farmers monitoring P levels? Are they adjusting cattle feed? Anything else?</b></p> | <p><b>Is there a reduction in P use? How much \$ saved? Other benefits? Negative consequences?</b></p> |
|--|--|---|---|---|--|

#### Indicators: How will you know it?

|  |   |   |   |   |   |
|--|---|---|---|---|---|
| <p><b># staff; \$ invested; delivery timetable</b></p> | <p><b># workshops, data systems, on-farm visits. Farmer self-reports of quality</b></p> | <p><b>Actual vs. desired attendance. #, % attended per session.</b></p> | <p><b>#, % with increased knowledge of ... Additional outcomes: +, -.</b></p> | <p><b>#, % monitoring P levels; making adjustments to cattle feed. Additional outcomes: +, -.</b></p> | <p><b>#, % reducing P use; level of reduction. # Dollars saved/farmer. Additional outcomes: +, -.</b></p> |
|--|---|---|---|---|---|

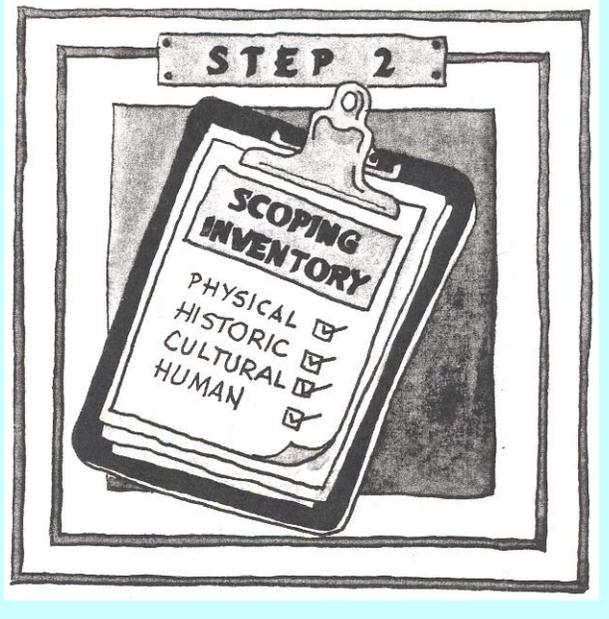
**Logic Model of**



# PHASE I PEOPLE DESIGN



## Step 2: Scope Inventory (Physical, People and Information)



“ The environment is no longer one of many single issues, it is the context of everything else-our lives, our business and politics. The great challenge of our time is to build and nurture sustainable social, cultural and physical environments in which we can satisfy our needs and aspirations without diminishing the chances for future generations. ”

**Fritjof Capria**

**About This Step** - *This step is designed to accomplish 5 things:*

In the context of identified monitoring and assessment activities:

1. A brainstorm list of information needs related to Monitoring & Assessment (M &A) activities designed to achieve identified outcome(s).
2. Identify what watershed(s) and water bodies, rivers, lakes and/or wetlands of interest, Physical Inventory Tier 1.
3. Develop a mechanism to document what you have and will obtain, *Master Inventory List* and a plan to obtain what you need, *Inventory Action Plan*.
4. A physical inventory of what you know or have and what you need for your watershed and each water body, Physical Inventory Tier 2-3.
5. A historic, cultural (Tier 1), relationship (people) (Tier 2) and information inventory (Tier 3), what you know and what you need for each water body/watershed regarding history, people and existing information.

## Why Do This Step?

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Why conduct an inventory? Why conduct an inventory as the first step of watershed assessment and monitoring? Both of these are relevant questions. Both answers will depend upon your individual organization's situation. In general, monitoring programs will fall into three categories in context with the value and relevance of conducting an inventory:

1. The group who has an idea of their vision and desired outcomes but doesn't really know what activities to conduct, and they haven't started monitoring yet.
2. The group that has an idea of their vision and desired outcomes a defined vision, outcomes and outputs, has monitored but cannot link results to progress, action or cannot turn results into information and or deliver that information and measure/evaluate work.
3. The group that does not have one or more of the following defined, a vision, outcomes, outputs or monitoring questions and has started monitoring

In all three cases, an inventory will give you a good idea of what's already known and help:

- √ Identify what needs to be done (gaps) and help define your niche or contribution (if only to validate existing decisions)
- √ Focus and prioritize your work
- √ Identify how your work compliments and/or duplicates other programs and why
- √ Identify potential partners
- √ Identify potential decision makers
- √ Identify existing data sources
- √ Make your monitoring and assessment results and other activities more robust and connected
- √ Identify your assessment in a larger physical and social context
- √ Provide a benchmark for evaluation

A store owner would never (in theory) open their store for sales before having an inventory of the goods. Likewise, we don't want to start a watershed monitoring and assessment program before having a sense of what is "out there" so we can strategically determine our added value, our competition and the need as perceived by others not ourselves. By carrying out this step, you define how your monitoring and assessment work fits in the watershed, over time, over space and functionally. It is not uncommon for programs to change direction or activities based upon an inventory alone.

The question may still beg to you, why conduct an inventory first thing, before visioning or establishing monitoring questions? If you conduct an inventory deeper into the process you lose some of the value of the discovery process. You may find the discovery value in conducting an inventory might take you in a different direction than assessment or monitoring. We often lose the power of discovery and the resourcefulness it brings if we don't conduct an inventory or do an inventory with too narrow a focus. In this framework, we come back to our inventory in later steps after we have determined our monitoring questions. But know that there is no right or wrong time to conduct an inventory.

Watershed inventories are an on-going process that is never complete, because the world is not static, you are always adding to this body of knowledge, you make progress toward your vision and outcomes, and your activities change in response. The rigor may vary among groups but a watershed inventory is essential for strategic determination of where your work will be most effective within your limitations.

A *holistic* inventory entails gathering as much existing information as you can about the watershed, its people, culture, history, economy, and more, so that you can focus your assessment efforts on work that will fill in information gaps on issues that are important to you. The reason to broaden your inventory beyond just physical features is to discover resources and help refine a focus for your work, targeted partnerships and decision-makers and reduce duplication while leveraging resources. Often misdirected, duplicated efforts or new opportunities are discovered in an inventory, just like cleaning the attic. In addition, your inventory can provide a piece of your evaluation benchmarks to assess effectiveness of your work.

Another way to describe the essence of this step is to ask in context with the monitoring and assessment activities that will achieve identified results (outcomes), *what do you know, what do you need/want to know and what will you do to find out?* Your inventory will become fine-tuned by going through the next steps which serve as a “filter” to focus your inventory needs.

This is plan though and not implementation, so here we will identify what you have, provide a mechanism to document it and plan to obtain what you need. As you implement the *Inventory Action Plan* and update your *Master Inventory List*.

## Where are we in the Big Picture Illustration?

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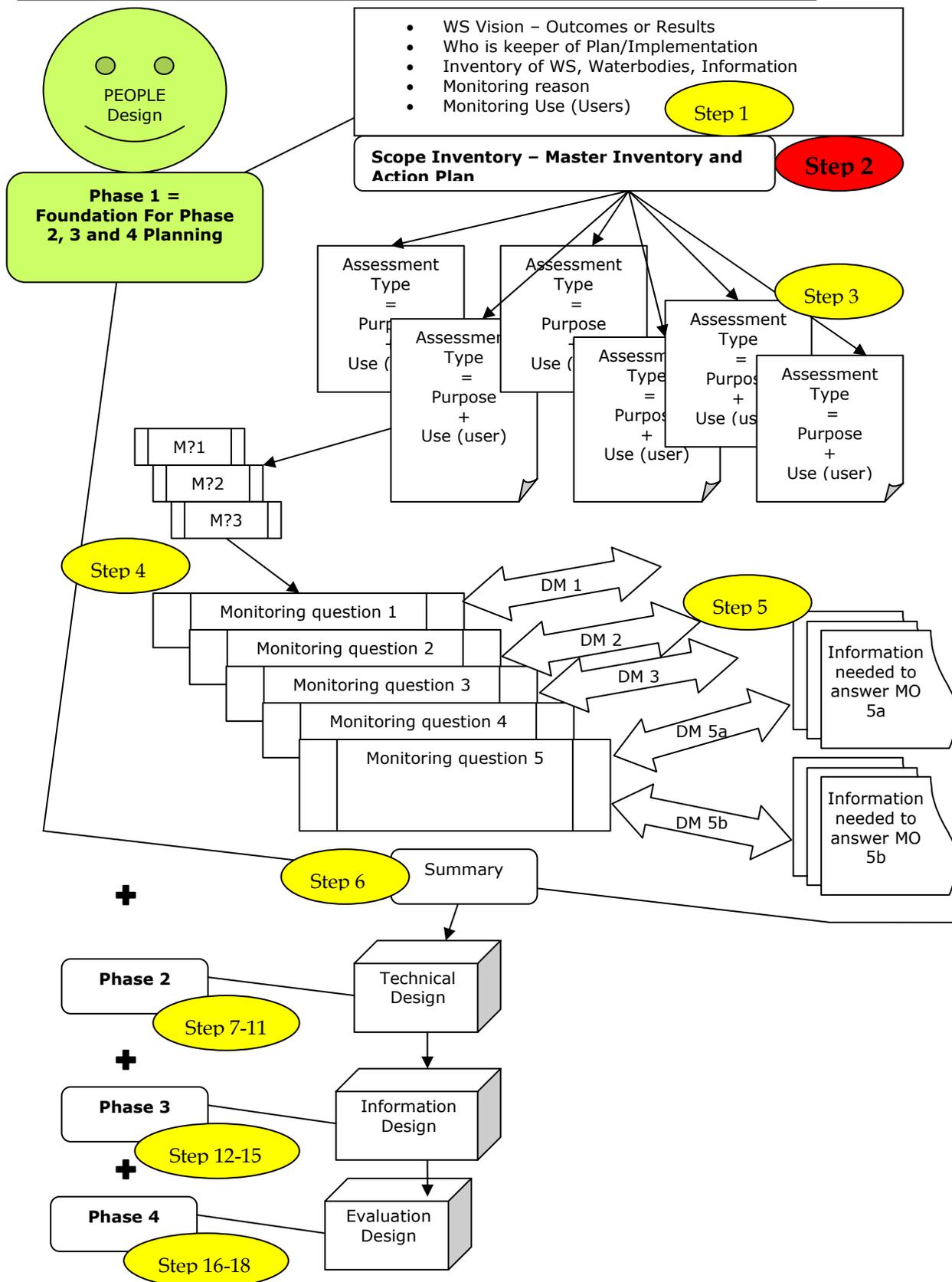
|         |  |
|---------|--|
| Phase 1 | Step 1: Share Watershed Vision and Desired Outcomes (Results)<br> <b>Step 2: Scope Inventory (Physical, People and Information)</b><br>Step 3: Identify Monitoring Reason(s) and Data Use(s) (Assessment Type)<br>Step 4: Develop Monitoring Questions (Refinement of Monitoring Reason)<br>Step 5: Target Decision Makers and Info Needs (Refinement of Data Use)<br>Step 6: Summarize with Information Blue Print-Data Pathway Fact Sheet |
| Phase 2 | Step 7: What Will You Monitor?<br>Step 8: When Will You Monitor?<br>Step 9: Where Will You Monitor?<br>Step 10: How Will You Monitor to Meet Data Quality Objectives?<br>Step 11: Management of Raw Data (Data Management Plan Part 1)   |
| Phase 3 | Step 12: Data Summary and Analysis<br>Step 13: Interpretation, Conclusions and Recommendations<br>Step 14: Communicating and Delivery<br>Step 15: Management to Generate Info (Data Management Plan Part 2)  |
| Phase 4 | Step 16: Who Will Do What? Task Identification<br>Step 17: Evaluation of Effectiveness (of Plan and Implementation)<br>Step 18: Documentation and Communication (of M & A Plan)  |

## Products (see Figure Phase 1 Product List):

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- √ Statement of need and Monitoring and Assessment (M & A) context for inventory.
- √ A list of information needs related to M & A activities.
- √ A defined watershed boundary and list of water bodies (rivers, lakes and/or wetlands) you will focus.
- √ A mechanism to document current and future inventory, called *Master Inventory List*, in this workbook. This List will document the content and status of different types of inventory for organization/project to serve as an inventory benchmark for which others can conduct inventories from where you left off.
- √ An *Inventory Action Plan*, to fulfill identified gaps and needs from this workbook.
- √ Including watershed boundary, water bodies of interest, status and use.
- √ A physical inventory review and summary of what you know, have or need regarding physical attributes, status, use/condition and impacts.
- √ A people inventory review and summary of what you know, have or need regarding historical, cultural, relationships and information.
- √ Actual data and information generated from the inventory.

Phase 1 Product Illustration:



## What Should Be Done Before This Step

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The context and purpose for the inventory, thus the identification of general / specific, planned or existing monitoring and assessment activities. If this is not the context, the context needs to be provided. Phase 1, Step 1 results generated a watershed vision and measurable outcomes, associated activities and target audiences related to monitoring and assessment activities. Further refinement of target audiences was completed and a list of decision makers and the decision they would make was also generated. The watershed vision and outcomes had a delineated watershed boundary and scope.

If you did not complete Phase 1, Step 1, you need to define the context of this inventory, what are the monitoring and assessment activities this inventory will address? Identify the general watershed boundary of focus. This initial watershed boundary may or may not need to be adjusted as you continue to plan, but at least identify the starting point. Whatever this boundary looks like, it “frames” your inventory and you proceed to “discover” everything within it.

A reminder to complete each task that is meaningful at this time, place items you cannot complete but desire to in your action plan. Also, this step provides ideas and starting points, at any time, deviate. The ultimate goal is to the degree appropriate determine what you know and need to know and who is doing what, where.

Inventory is a never ending process and can seem overwhelming and too large to even start. If at any time this is true for you, subset the focus, narrow the context, so that the act of gathering information remains meaningful and doable. This is plan though and not implementation, so here we will identify what you have, provide a mechanism to document it and plan to obtain what you need. As you implement the *Inventory Action Plan* and update your *Master Inventory List*.

## Basic Tasks

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Basic Tasks are numbered to correlate with the overall 1-18 Steps provided in these guidance modules followed by the basic task sequence step to complete. For example Step 4, basic task 2 would be numbered as Basic Task Step 4.2, Step 3.3 correlates to Step 3, Basic Task 3.



- 2.1 Identify who will make the decisions about this step and who should be involved in the planning process (they may be different).



- 2.2 Self Assessment: Identify what decisions have been made and their effectiveness

### *INVENTORY PREPARATION AND CONTEXT:*



- 2.3 Identify Monitoring and Assessments Activities and needed information.

*List the monitoring and assessment activities served by this inventory and general time line or span (how far back and into the future will you look?). Brainstorm information desired from each monitoring and assessment activity.*



- 2.4 Start a *Master Inventory List* or equivalent to document what you already have and what you will be generating for others, future staff, members, stakeholders, etc. Tasks below will ask you to place what you have in this list or what you need in the next, Action Plan, list.

*Review the list provided in the Background and Content Section and decide what Inventories you need to conduct.*



- 2.5 Start an *Inventory Action Plan*. This is where you place inventories you want or need to conduct but cannot right now. It can be used for resource planning and communication. It may be that you have no existing inventory and all your needs are in this document.

### *PHYSICAL INVENTORY TIER I - IDENTIFY WATERSHED AND WATER BODIES FOR FOCUS:*



- 2.6 Map or illustrate the watershed boundary or boundaries, provide explanation as to why this scale and scope is appropriate.



- 2.7 Identify on a map (hand made or otherwise) and/or in a list the water bodies of interest. Identify whether they are surface waters, ground waters, lakes or rivers and or wetlands (types if appropriate). Document location information (how to drive to them,

photographs, utmx and y, latitude/longitude, township-range-section-1/4 section, physical description, etc.).



2.8

Assess what you know and have against what you need regarding the target water body list. Identify goals and gaps. Record in *Inventory Action Plan*.

*PHYSICAL INVENTORY TIER 2 – PHYSICAL ATTRIBUTES WITHIN WATERSHED AND WATER BODIES OF FOCUS:*



2.9

Review the possible physical attribute categories in the Background and Content Section. For each watershed, water body or what “unit” you are using, identify what you already have in each relevant physical inventory category. Document what you find in the *Master Inventory List*. **Caution:** If this list is too large, subset, categorize and prioritize.



2.10

Assess what you have against known needs. *Identify gaps*. Place those needs in the *Inventory Action Plan*.

*PHYSICAL INVENTORY TIER 3 – WATER BODY SPECIFIC*



2.11

For each water body list existing and potential impact features (sources). Document what you know or have in *Master Inventory List*, place what you need in *Inventory Action Plan*.



2.12

For each water body list existing and potential physical, chemical, biological and or human stressors (pollutants). Document what you know or have in *Master Inventory List*, place what you need in *Inventory Action Plan*.



2.13

For each water body list existing uses, status of those uses, classifications and condition (based upon own definition or system or someone else’s, the state’s Clean Water Act, etc.). Document what you know or have in *Master Inventory List*, place what you need in *Inventory Action Plan*.

*PEOPLE INVENTORY – TIER 1 HISTORY AND CULTURE OF WATERSHED*



2.14

Review the options and purpose for historical and cultural inventory in Background and Content Section. For each watershed, water body or what “unit” you are using, document what you know or have in *Master Inventory List*, and place what you need in *Inventory Action Plan*.

### PEOPLE INVENTORY – TIER 2 RELATIONSHIP INVENTORY



- 2.15 Review the options for relationship inventory in Background and Content Section. For each watershed, water body or what “unit” you are using, document what you know or have in *Master Inventory List*, and place what you need in *Inventory Action Plan*.

### PEOPLE INVENTORY – TIER 3 INFORMATION INVENTORY



- 2.16 Review the options for information inventory in the Background and Content Section. For each watershed, water body or what “unit” you are using, document what you know or have in *Master Inventory List*, and place what you need in *Inventory Action Plan*.



- 2.17 If plan to use existing data, conduct a relevant review. Purpose is to determine if the data is relevant and the appropriate quality for your monitoring and assessment reason and questions and information needs of the targeted decision makers. You evaluate the existing data for their monitoring reason and technical design for relevance, comparability, reliability, quality and quantity. This would include assessment of indicators, locations, duration, frequency and methods. *Step 2 Resource Guide* provides a quality check list to evaluate existing data. For the plan, put the existing data source in the *Master Inventory Plan* and if don't know the relevance of the data set, put the data source in the *Inventory Action Plan*.



- 2.18 Prioritize *Inventory Action Plan*, arrange in priority order. Implement.



- 2.19 Update *Master Inventory List*.

As each nugget of information is obtained mark it off the plan and add each item to the *Inventory Master List* and update the *Inventory Action Plan*. Identify what the item is, date the item, identify source and where and how the information will be stored. You can include other information such as who conducted inventory, assumptions, costs and tools used. This documentation effort helps retain institutional knowledge for the future.



- 2.20 Place Products in your *Watershed Monitoring and Assessment Plan*.



- 2.21 Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan).

## Worksheets

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Work sheets are listed below. Not all Basic Tasks have an associated work sheet. To simplify completion of products for each step, the worksheets are broken into small subsets of tasks. This requires moving the results of one task into the next task and will seem redundant, especially if completing worksheets by hand. Worksheets are provided in word here for ease of reproducibility. These are a starting point, we encourage you to customize these and reproduce them in an electronic format, in Excel for example, where it is easy to move information from one area to another by cutting and pasting.

Work Sheets are numbered to correlate with Basic Steps and the overall Steps in these guidance modules. Each consecutive work sheet is lettered a, b, c and so forth, preceded by the Basic Task sequence step, preceded by the Step number. For example, *Worksheet Step 4.2.a* and *Step 4.2.b*, correlates to Step 4, Basic Task 2, *Worksheet a* and *Worksheet b*. In theory worksheet *a* needs to be completed before worksheet *b*.

### **Worksheet 2.2.a Self Assessment Step 2 Worksheet and Products to be completed Prior to this Step**

*IDENTIFY MONITORING AND ASSESSMENTS ACTIVITIES AND NEEDED INFORMATION.*

**Worksheet 2.3.a List the monitoring and assessment activities served by this inventory and general time line or span (how far back and into the future will you look?). Brainstorm information desired from each monitoring and assessment activity.**

**Worksheet 2.4.a Start a *Master Inventory List* or equivalent to document what you already have and what you will be generating for others, future staff, members, stakeholders, etc.**

**Worksheet 2.5.a Start an *Inventory Action Plan***

This is where you place inventories you want or need to conduct but cannot right now. It can be used for resource planning and communication. It may be that you have no existing inventory and all your needs are in this document.

*PHYSICAL INVENTORY TIER 1 - IDENTIFY WATERSHED AND WATER BODIES FOR FOCUS:*

**Worksheet 2.7.a Water body list and location information, to accompany a map (hand made or otherwise).**

*PHYSICAL INVENTORY TIER 2 – PHYSICAL ATTRIBUTES WITHIN WATERSHED AND WATER BODIES OF FOCUS:*

**Worksheet 2.9.a Physical Attribute Inventory Documentation**

*PHYSICAL INVENTORY TIER 3 – WATER BODY SPECIFIC*

**Worksheet 2.11.a Water body Impact Feature Inventory and Documentation**

**Worksheet 2.12.a Water body Stressor Inventory and Documentation**

**Worksheet 2.13.a Water body Status/Condition and Use Inventory and Documentation**

*PEOPLE INVENTORY – TIER 1 HISTORY AND CULTURE OF WATERSHED*

**Worksheet 2.14.a      Historical and Cultural People Inventory and Documentation**

*PEOPLE INVENTORY – TIER 2 RELATIONSHIP INVENTORY*

**Worksheet 2.15.a      Relationship Inventory and Documentation**

*PEOPLE INVENTORY – TIER 3 INFORMATION INVENTORY*

**Worksheet 2.16.a      Information Inventory and Documentation**

**Worksheet 2.17.a      Existing Data Inventory, Quality Check and Documentation**

**Worksheet 2.20.a      Place Products in your *Watershed Monitoring and Assessment Plan*.**

**Worksheet 2.21.a      Final Action Plan Part 1, Summary:**

## How to do Worksheets

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**For Sheet 2.2.a      Self Assessment: Identify what decisions have been made and their effectiveness.**

Part 1. Complete the self assessment section of the worksheet to evaluate what you have or what decisions have already been made. This will help you focus on what you need from this step and incorporate valuable existing information or products into this plan.

Part 2. Next, to prepare to complete this step the following, you need to have the following items addressed:

- √ Desired set of outcomes or results that the monitoring and assessment activities will be designed to help achieve
- √ Generally identified monitoring and assessment activities,

This is the ideal list, if you do not have any of these, they become a gap or need that should be addressed before any data is collected or analyzed, even if the answers aren't perfect or you don't have a large degree of confidence surrounding them, they should be attempted as the starting point. This is what you are evaluating in this step-your monitoring and assessment plan.

**Worksheet 2.2.a Self Assessment Step 2 Worksheet and Products to be completed Prior to this Step, Part 1**

*Part 1 Self Assessment of Known Evaluation Products and Processes*

- 1. Determine if you “have” or “don’t have” the item, mark the appropriate box. If you don’t have it and determine you don’t need it, explain why in the comments document. You may not need to know but perhaps your target decision makers, board or membership might want to know.**
- 2. If you have the item “documented”, mark that box. If so, list in the comments where, hard copy, chapter in a document, electronic file name and location, etc. The assumption is you value the ultimate goal to document and communicate your M & A plan, activities and results.**
- 3. If you have the item, assess the use of it, use the scale below or provide your own answer and comments.**

Rating Scale for USE:

- 0=doesn’t exist so use is nil
- 1=don’t know why would need or understand item
- 2=exists, don’t know where it is, if it is used, etc. so use is essentially nil
- 3=exists and use some of time
- 4=exists and use all the time
- 5=wish it existed, would use it lots

- 4. If you have the item, assess the effectiveness of it, just because something exists or is used does not mean it is effective in its use, use the effectiveness scale below or provide your own answer and comments.**

Rating Scale for EFFECTIVENESS, assumes material exists:

- 0=not effective or functional at all
- 1=incomplete (all elements are not there) and some existing parts need revising
- 2=incomplete but what is there is okay
- 3=complete (all elements are there), some parts okay but need revising
- 4=complete and effective

| Item  | Have | Don't Have | DOC | Assessment of Use (Scale 0-5) | Assessment of Value / Effectiveness (Scale 0-4) | Comments |
|---|------|------------|-----|-------------------------------|---|----------|
| 5. Physical inventory Tier 1, defined geographic scope your are working in, List of water bodies of interest (rivers, lakes or wetlands), |      |            |     |                               |   |          |
| 6. Maps of watershed, area of interest, other? (draw a map if need to)  |      |            |     |                               |   |          |
| 7. Physical Inventory Tier 2, features, biological, etc. for water bodies   |      |            |     |                               |   |          |
| 8. Physical Inventory Tier 3, status and condition of water bodies  |      |            |     |                               |   |          |

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
| 9. For water bodies of concern, evaluation of status or condition, by self, locals, DEQ, other |  |  |  |  |  |  |
| 10. For water bodies of concern threats identified areas needing protection identified         |  |  |  |  |  |  |
| 11. People Inventory Tier 1, cultural, historical  |  |  |  |  |  |  |
| 12. People Inventory Tier 2, People, power and relationships                                   |  |  |  |  |  |  |
| 14. Inventory of reports or significant documents in your scope of interest                    |  |  |  |  |  |  |
| 15. Identified existing data could use and have completed data quality review of it            |  |  |  |  |  |  |
| Other?   |  |  |  |  |  |  |

\*DOC=Documentation, \*M & A= Monitoring and Assessment

**5. To make this assessment useful, determine what your gaps and needs are regarding this step in order to focus your effort in completing this step.**

**Worksheet 2.2.a Self Assessment Step 2 Worksheet and Products to be completed Prior to this Step, Part 2**

*Part 2 Products to be completed before this step, in order to complete this step*

| Item   | Response |
|--|----------|
| Desired set of outcomes or results that the monitoring and assessment activities will be designed to help achieve: |          |
| General idea of monitoring reason and data use(r) to achieve desired outcomes:                                     |          |

*IDENTIFY MONITORING AND ASSESSMENTS ACTIVITIES AND NEEDED INFORMATION.*

**For Sheet 2.3.a Identify Monitoring and Assessments Activities and needed information.**

*Review the list of general monitoring and assessment activities you produced in Step 1. List those as specific as possible on Worksheet 2.3.a. For each of those brainstorm the information you need that monitoring and assessment activity to produce. Think of it as the questions you want answered it that helps.*

**Worksheet 2.3.a List the monitoring and assessment activities served by this inventory and general time line or span (how far back and into the future will you look?). Brainstorm information desired from each activity.**

| Monitoring and Assessment Activity | Information Desired | General Time Span |
|------------------------------------|---------------------|-------------------|
|                                    |                     |                   |
|                                    |                     |                   |
|                                    |                     |                   |
|                                    |                     |                   |
|                                    |                     |                   |
|                                    |                     |                   |
|                                    |                     |                   |

**For Sheet 2.4.a**      **Start a *Master Inventory List* or equivalent to document what you already have and what you will be generating for others, future staff, members, stakeholders, etc. Tasks below will ask you to place what you have in this list or what you need in the next, Action Plan, list.**

*Review the list provided in the Background and Content Section and decide what Inventories you need to conduct. Add columns as they make sense to track, so edit to serve your needs.*

**Worksheet 2.4.a**     **Start a *Master Inventory List* or equivalent to document what you already have and what you will be generating for others, future staff, members, stakeholders, etc. Tasks below will ask you to place what you have in this list or what you need in the next, *Action Plan*, list.**

*Review the list provided in the Background and Content Section and decide what Inventories you need to conduct. Add columns as they make sense to track, so edit to serve your needs.*

| <b>MASTER INVENTORY LIST</b>               |      |              |        |                   |
|--|------|--------------|--------|-------------------|
| <b>Monitoring and Assessment Activity:</b> |      |              |        | Page ____ of ____ |
| <b>Inventory Type:</b>                     |      |              |        |                   |
| Item                                       | Date | Where stored | Format | ?                 |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |

**For Sheet 2.5.a** Start an *Inventory Action Plan*. This is where you place inventories you want or need to conduct but cannot right now. It can be used for resource planning and communication. It may be that you have no existing inventory and all your needs are in this document.

**Worksheet 2.5.a** Start an *Inventory Action Plan*. This is where you place inventories you want or need to conduct but cannot right now. It can be used for resource planning and communication. It may be that you have no existing inventory and all your needs are in this document.

| <b>INVENTORY ACTION PLAN</b>               |      |              |        |                   |
|--|------|--------------|--------|-------------------|
| <b>Monitoring and Assessment Activity:</b> |      |              |        | Page ____ of ____ |
| <b>Inventory Type:</b>                     |      |              |        |                   |
| Item                                       | Date | Where stored | Format | ?                 |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |
|  |      |              |        |                   |

*PHYSICAL INVENTORY TIER 1 - IDENTIFY WATERSHED AND WATER BODIES FOR FOCUS:*

**For Sheet 2.7.a Identify on a map (hand made or otherwise) and/or in a list the water bodies of interest. Identify whether they are surface waters, ground waters, lakes or rivers and or wetlands (types if appropriate).**

*Document location information (how to drive to them, photographs, utmx and y, latitude/longitude, township-range-section-1/4 section, physical description, etc.). Edit this worksheet to have meaningful columns. If you don't know location information, then put that in the Inventory Action Plan.*

**Worksheet 2.7.a Water body list and location information, to accompany a map (hand made or otherwise)**

| Monitoring and Assessment Activity: |      |                    |          |           | Page ____ of ____ |
|-------------------------------------|------|--------------------|----------|-----------|-------------------|
| Water body Name                     | Type | How to Drive there | Latitude | Longitude | Ownership         |
|                                     |      |                    |          |           |                   |
|                                     |      |                    |          |           |                   |
|                                     |      |                    |          |           |                   |
|                                     |      |                    |          |           |                   |
|                                     |      |                    |          |           |                   |
|                                     |      |                    |          |           |                   |
|                                     |      |                    |          |           |                   |
|                                     |      |                    |          |           |                   |

*PHYSICAL INVENTORY TIER 2 – PHYSICAL ATTRIBUTES WITHIN WATERSHED AND WATER BODIES OF FOCUS:*

**For Sheet 2.9.a**      **Review the possible physical attribute categories in the Background and Content Section. For each watershed, water body or what “unit” you are using, identify what you already have in each relevant physical inventory category. Document what you find in the *Master Inventory List*. Caution: If this list is too large, subset, categorize and prioritize.**

- Geology (zones, regions, types, etc.)
- Ecology (zones, regions, etc.)
- Physiological
- Vegetative Zones or Types
- Precipitation and Climate
- Plants
- Animals
- Background or Baseline water chemistry (soil, etc.)
- Hydrology and Morphology
- Physical Habitat Structure and condition
- Land Use
- Water Use
- Water Ownership
- Etc.



*PHYSICAL INVENTORY TIER 3 – WATER BODY SPECIFIC*

**For Sheet 2.11.a** For each water body list existing and potential impact features (sources). Add this List B to the *Master Inventory List*, place what you need in *Inventory Action Plan*. Review the impact feature list in **Background Content Section**, a starter list is below:

- cities
- bridges
- land use
- water use
- diversion points
- roads (types)
- NPDES discharges
- land ownership
- water ownership
- discharge permits
- culverts
- % impervious surface
- residential densities
- epidemiology
- channelized stretches



**For Sheet 2.12.a** For each water body list existing and potential physical, chemical, biological and or human stressors (pollutants). Add List C to the *Master Inventory List*, place what you need in *Inventory Action Plan*. Below is a starter table.

Potential Watershed Stressors/Threats

| Pollution from specific locations ("Point sources")  | Resulting from sources such as:   |
|--|---|
| Acid mine drainage<br>Impoundments<br>Injection wells<br>Direct sewage discharge<br>Leaking underground storage tanks<br>Water withdrawals | Wastewater treatment plants<br>Food processing plants<br>Large animal feedlots<br>Pulp or paper producing plants<br>Power plants<br>Mines<br>Dams   |
| Pollution from land areas ("Non-point sources")  | Resulting from sources such as:   |
| Fertilizers<br>Herbicides and pesticides<br>Raw sewage<br>Exotic plant and animal species<br>Petroleum residues<br>Soil<br>Metals          | Lawns<br>Farms<br>Recreation and tourism<br>Underground and above ground storage tanks<br>Air pollution<br>Landfills<br>Unofficial or abandoned dump sites<br>Failing septic systems<br>Automobiles<br>Poor forestry practices<br>Paved surfaces<br>Construction sites<br>Removal of streamside vegetation<br>Stocking and planting of non-Native species |

**Worksheet 2.12.a Water body Stressor Inventory and Documentation**

For each water body list existing and potential physical, chemical, biological and or human stressors (pollutants). Add List C to the **Master Inventory List**, place what you need in **Inventory Action Plan**. Edit to satisfy needs.

| <b>WATERBODY LIST C</b>                    |                 |                     |                 |                   |
|--|-----------------|---------------------|-----------------|-------------------|
| <b>Monitoring and Assessment Activity:</b> |                 |                     |                 | Page ____ of ____ |
| <b>Water body Name</b>                     | <b>Stressor</b> | <b>Pollutant(s)</b> | <b>How Know</b> | <b>Comments</b>   |
|  |                 |                     |                 |                   |
|  |                 |                     |                 |                   |
|  |                 |                     |                 |                   |
|  |                 |                     |                 |                   |
|  |                 |                     |                 |                   |
|  |                 |                     |                 |                   |
|  |                 |                     |                 |                   |
|  |                 |                     |                 |                   |
|  |                 |                     |                 |                   |
|  |                 |                     |                 |                   |

**For Sheet 2.13.a** For each water body list existing uses, status of those uses, classifications and condition (based upon own definition or system or someone else's, the state's Clean Water Act, etc.). Add List D to the *Master Inventory List*, place what you need in *Inventory Action Plan*.

**Worksheet 2.13.a Water body Status/Condition and Use Inventory and Documentation.**

For each water body list existing uses, status of those uses, classifications and condition (based upon own definition or system or someone else's, the state's Clean Water Act, etc.). Add List D to the *Master Inventory List*, place what you need in *Inventory Action Plan*. Edit to meet your needs.

| <b>WATERBODY LIST D</b>                    |                     |                          |      |            |                   |
|--|---------------------|--------------------------|------|------------|-------------------|
| <b>Monitoring and Assessment Activity:</b> |                     |                          |      |            | Page ____ of ____ |
| Water body Name                            | Status or Condition | What Criteria Definition | Know | Don't Know | Comments          |
|  |                     |                          |      |            |                   |
|  |                     |                          |      |            |                   |
|  |                     |                          |      |            |                   |
|  |                     |                          |      |            |                   |
|  |                     |                          |      |            |                   |
|  |                     |                          |      |            |                   |
|  |                     |                          |      |            |                   |

PEOPLE INVENTORY – TIER I HISTORY AND CULTURE OF WATERSHED

**For Sheet 2.14.a** Review the options and purpose for historical and cultural inventory in Background and Content Section. For each watershed, water body or what “unit” you are using, add LIST E to the *Master Inventory List*, place what you need in *Inventory Action Plan*.

**Worksheet 2.14.a** Historical and Cultural People Inventory and Documentation.

Review the options and purpose for historical and cultural inventory in Background and Content Section. For each watershed, water body or what “unit” you are using, add LIST E to **Master Inventory List**, place what you need in **Inventory Action Plan**. Edit to serve your need, there may be more meaningful was to capture what you know/need. .

| WATERBODY LIST E                    |            |          |           |        |                   |
|-------------------------------------|------------|----------|-----------|--------|-------------------|
| Monitoring and Assessment Activity: |            |          |           |        | Page ____ of ____ |
| Water body Name                     | Historical | Cultural | Political | Social | Comments          |
|                                     |            |          |           |        |                   |
|                                     |            |          |           |        |                   |
|                                     |            |          |           |        |                   |
|                                     |            |          |           |        |                   |
|                                     |            |          |           |        |                   |
|                                     |            |          |           |        |                   |

*PEOPLE INVENTORY – TIER 2 RELATIONSHIP INVENTORY*

**For Sheet 2.15.a**      **Review the options for relationship inventory in Background and Content Section. For each watershed, water body or what “unit” you are using, add List F to the *Master Inventory List*, place what you need in *Inventory Action Plan*. Pick from the following list what is relevant:**

- Values
- Perceived Threats
- Actual Use
- Stakeholders
- Relationships?
- Statutes and Programs
- Other?

**Worksheet 2.15.a Relationship Inventory and Documentation.**

Review the options for relationship inventory in Background and Content Section. For each watershed, water body or what "unit" you are using, add List F to **Master Inventory List**, place what you need in **Inventory Action Plan**. Edit to serve your needs.

| <b>WATERBODY LIST F</b>                    |                   |            |              |                |                   |
|--|-------------------|------------|--------------|----------------|-------------------|
| <b>Monitoring and Assessment Activity:</b> |                   |            |              |                | Page ____ of ____ |
| <b>Water body Name:</b>                    |                   |            |              |                |                   |
| Values                                     | Perceived Threats | Actual Use | Stakeholders | Relationships? | Statutes Programs |
|  |                   |            |              |                |                   |
|  |                   |            |              |                |                   |
|  |                   |            |              |                |                   |
|  |                   |            |              |                |                   |
|  |                   |            |              |                |                   |
|  |                   |            |              |                |                   |
| <b>Water body Name:</b>                    |                   |            |              |                |                   |
|  |                   |            |              |                |                   |
|  |                   |            |              |                |                   |

*PEOPLE INVENTORY – TIER 3 INFORMATION INVENTORY*

**For Sheet 2.16.a**      **Review the options for information inventory in the Background and Content Section. For each watershed, water body or what “unit” you are using, add List H to the *Master Inventory List*, place what you need in *Inventory Action Plan*.**

**Worksheet 2.16.a Information Inventory and Documentation.**

Review the options for information inventory in the Background and Content Section. For each watershed, water body or what "unit" you are using, add LIST H to **Master Inventory List**, place what you need in **Inventory Action Plan**. Edit to meet your needs.

| <b>WATERBODY LIST H</b>                    |                   |
|--|-------------------|
| <b>Monitoring and Assessment Activity:</b> | Page ____ of ____ |
| <b>Water body Name:</b>                    |                   |
| Decision Makers/Relationships:             |                   |
| Existing M & A Effort:                     |                   |
| What do I know about Effort?               |                   |
| Existing Data                              |                   |
| <b>Water body Name:</b>                    |                   |
| Decision Makers/Relationships:             |                   |
| Existing M & A Effort:                     |                   |
| What do I know about Effort?               |                   |
| Existing Data                              |                   |

**For Sheet 2.17.a      If plan to use existing data, conduct a relevant review.**

*Purpose is to determine if the data is relevant and the appropriate quality for your monitoring and assessment reason and questions and information needs of the targeted decision makers. You evaluate the existing data for their monitoring reason and technical design for relevance, comparability, reliability, quality and quantity. This would include assessment of indicators, locations, duration, frequency and methods. Step 2 Resource Guide provides a quality check list to evaluate existing data. For the plan, put the existing data source in the **Master Inventory Plan** and if don't know the relevance of the data set, put the data source in the **Inventory Action Plan**.*

*You might complete this in Step 5 or later when you have defined your monitoring and assessment more specifically. **Step 5 Resource Guide** as a data quality check list to use to evaluate existing data against your needs.*

**Worksheet 2.17.a Existing Data Inventory, Quality Check and Documentation.**

| <b>W A T E R B O D Y   L I S T I</b>       |                              |
|--|------------------------------|
| <b>Monitoring and Assessment Activity:</b> | Page ____ of ____            |
| <b>Water body Name:</b>                    | <b>Existing Data Source:</b> |
| Purpose:                                   |                              |
| Indicators:                                |                              |
| Stations:                                  |                              |
| Methods, Data Quality Objective's:         |                              |
| Quantity (time frame):                     |                              |
| <b>Water body Name:</b>                    | <b>Existing Data Source:</b> |
| Purpose:                                   |                              |
| Indicators:                                |                              |
| Stations:                                  |                              |
| Methods, Data Quality Objective's:         |                              |
| Quantity (time frame):                     |                              |

**For Sheet 2.20.a** Place Products in your *Watershed Monitoring and Assessment Plan*.

- √ Watershed Boundaries and list of Water bodies M & A will focus
- √ Master Inventory List
- √ Physical Attributes Existing Inventory
- √ People Existing Inventory
- √ Information Existing Inventory
- √ Existing Monitoring Efforts
- √ Existing Data Sources
- √ Inventory Action Plan

**Worksheet 2.20.a** Place Products in your *Watershed Monitoring and Assessment Plan*.

I. People Design, Phase 1

- A. Shared Watershed Vision and Desired Outcomes (Step 1)
  - 1. Logic Model of Desired Outcomes/Results and activities/target audiences to employ to achieve outcomes
- B. Keepers of the M & A Plan (Step 1)
- C. → Watershed Boundary (Step 2)
- D. → Water bodies of Interest (Step 2)
- E. → Scope Master Inventory List\* (Step 2)
  - 1. → Physical Inventory\* (Step 2)
  - 2. → People Inventory\* (Step 2)
  - 3. → Information Inventory\* (Step 2)
    - a. → Existing Monitoring Efforts (Step 2)
    - b. → Existing Data Sources (Step 2)
  - 4. → Inventory Action Plan\* (Step 2)
- F. Assessment Type(s) List - Monitoring Reason + Use (Step 3)
  - 1. Monitoring Question(s) (Step 4)
  - 2. Targeted Decision Maker(s) (Step 5)
    - a. Information Needs (Step 5)
  - 3. Information Blue Print - Data Pathway Fact Sheet Per Monitoring Question\* (Step 6)

II. Technical Design, Phase 2

- A. What (Indicators, Benchmarks, etc.) and why? (Step 7)
- B. When and why? (Step 8)
- C. Where and why? (Step 9)
- D. W(how) will meet data quality objectives? (Step 10)
  - 1. Data quality objectives (Step 5 and 10)
  - 2. Quality Assurance and Control Measures (Quality Assurance and Control Plan)\* (Step 10)
- E. Data Management for Raw Data (Data Management Plan Part 1)\* (Step 11)

### III. Information Design, Phase 3

- A. Data Summary and Analyses (Step 12)
  - 1. Starting Point (Step 12)
  - 2. Changes (Later)
- B. Data Interpretation, Conclusions, Recommendations
  - 1. Starting Point (Step 13)
  - 2. Changes (Later)
- C. Communication and Delivery
  - 1. Starting Point (Step 14)
  - 2. Changes (Later)
- D. Management Plans to Generate Information (Data Management Plan Part 2)\* (Step 15)

### IV. Evaluation Design, Phase 4

- A. Who Will Do What? (Step 16)
  - 1. Task Identification Matrix (Step 16)
  - 2. Communication Structure and Tools (Step 16)
- B. Evaluation Plans (Step 17)
  - 1. Evaluation Plans for M & A Components (Step 17)
  - 2. Evaluation Plans for M & A Implementation (Step 17)
  - 3. Evaluation of inter/intra M & A Activities (Step 17)

C. Documentation and Communication (Step 18)

1. M & A Plan (**this document**, updated Sub documents) (Step 18)
2. Communication and Peer Review Plan (Step 18)
3. Action Plan\* (Step 17)

**For Sheet 2.21.a** Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan).

**Worksheet 2.21.a** Final *Action Plan Part 1, Summary:*

*If you have completed each Step, or for those you have, you have a cumulated list of gaps and needs related to that Step. Use that same worksheet/document. If you did not complete each Step, look at what each Step is supposed to accomplish and record what your gaps and needs are related to that topic. The goals are to get the gaps and needs in one place to evaluate and prioritize.*

**Phase 1 Step 1: (completed in Step 1)**

**Phase 1 Step 2:**

**Phase 2, 3 and 4 Steps: Will add Action and Needs as complete each Step and at the end prioritize**

## Background and Content

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### Inventory Preparation and Context

#### *DESIRED INFORMATION TO BE GENERATED BY MONITORING AND ASSESSMENT ACTIVITIES*

You need to identify existing and future monitoring and monitoring and assessment activities that provide the context for this scoping inventory. In theory, these monitoring and assessment activities are linked to at least one identified desired outcome or result. Once you have identified existing or future monitoring and assessment activities, for each of them, brainstorm the list of information that you think needs to be generated to achieve desired outcomes, results or decisions. Articulate the information needs however it makes sense to you, this can include a list of water bodies, indicators, sample stations, metrics, desired decisions or other items. This list will be used in later steps as well.

#### *SCOPE AND SCALE*

Before you begin any step, inventory or otherwise, you need to make an initial determination of the geographic boundary or watershed(s) boundaries in which you will focus. A holistic inventory involves gathering as much existing information as you can about the watershed, its people, culture, history, economy, and more, so that you can focus your assessment efforts on work that will fill in information gaps on issues that are important to you.

All of the following inventories are not essential; in fact work is often planned and conducted without any inventory effort. This also often leads to duplication, redundancy and frustration. All of the inventory types may not be relevant or appropriate for your monitoring and assessment focus. It is safe to state that you will learn something from each of them regardless of when they are conducted and for how long. So, consider each of them.

#### *TIME FRAME*

You may conduct pieces of this inventory over time while monitoring or do it all in one effort. The important task is to document what you are inventorying, and why, so there is a benchmark, for each inventory result, identify the source and where will the information be located, and then do the “process” of adjusting your watershed assessment and monitoring plan based upon what you learned from the inventory.

The context for this inventory is potential monitoring and assessment activities you have identified, either in Step 1 or here. Using this as the focus, the following is a list of the basic elements, with a partial list of what might go into each:

#### *DOCUMENTATION*

Determine how you will document and track inventory activities and results. Give this the attention it warrants, if the project is a one time, simple study, it may not require much inventory effort or documentation. If it is a multi-basin, multi-year, multi-organization effort, documentation could be invaluable for saving resources in the future and help in decision making. We suggest two types of

inventory documentation, document what you have/find and document an inventory needs or action plan. The former will help others learn what you might already know and where to find it. The latter will help you include inventory needs when planning future funding and activities. If neither of these ideas resonates, provide your own documentation and rationale.

### **Holistic Inventory Overview**

We encourage you too look beyond an inventory of the physical attributes of your watershed or water body. The physical attributes are essential and should be inventoried or assessed. If it is possible and relevant to the desired outcomes it can be very useful to know about historical events, cultural perspectives, uses and users, their perceptions, your current and desired relationship with key people, who is doing work in the watershed and what data already exists.

If you need to start this with a primer or with a fairly simple science 101 overview of watershed basics, try one that provided in *California Watershed Assessment Manual Draft*, [http://cwam.ucdavis.edu/Manual\\_chapters.htm](http://cwam.ucdavis.edu/Manual_chapters.htm), Chapter 3<sup>5</sup>. This Chapter covers basic watershed geography, hydrology, climate, flooding, storm water, geology, soils, sediment, water quality, aquatic ecosystems, wetland and riparian habitats, terrestrial habitats, human land uses, water management and uses, social and economic settings, historic context and more references.

#### *PHYSICAL INVENTORY*

Physical inventory, scientific, natural and human aspects that include – in relation to your monitoring and assessment activities:

##### *Tier 1 - Watershed and Water body Identification*

- ◆ Watershed boundary, scale and scope, time frame
- ◆ Water bodies (surface, ground and wetlands)
- ◆ Map(s)

##### *Tier 2 - Physical attributes within watershed and water body*

- ◆ Geological, ecological, physiological, regions
- ◆ Precipitation and climate zones
- ◆ Biological (plants and animals)
- ◆ Background and Baseline chemistry
- ◆ Hydrology
- ◆ Physical habitat structure, function, composition
- ◆ Land ownership and land use
- ◆ Special Features (e.g. scenic areas)
- ◆ Historical Significant Events or sites (drought, fires, floods, dams, etc.)

##### *Tier 3 - Water body specific*

- ◆ Water uses and users
- ◆ Impact Features perceived, existing and potential (e.g. pollution sources)

- ◆ Stressors ID (pollutants, processes that stress the ecosystem)
- ◆ Status and/or condition of water bodies

### *PEOPLE INVENTORY*

Cultural, historical and political inventory of your watershed, this may not influence the data you collect (but might), but will definitely be a major part of any changes that might result from the data collected. The type of people inventory could include – in relation to your monitoring and assessment activities:

#### *Tier 1 – Historical and Cultural People Inventory within Watershed*

- ◆ Historical People Inventory (who has lived there in past and their use, relationship with the water and perception of quality)
- ◆ Current People Inventory (who lives there now and their use, relationship with the water and perception of quality )
- ◆ Identification of significant historical or current social, political or cultural considerations

#### *Tier 2 – Relationship Inventory*

- ◆ Identification of Values, uses, perception and perceived threats/conditions
- ◆ Identification of Stakeholders
- ◆ Identification of Partnerships
- ◆ Relevant Statutes and Programs

#### *Tier 3 – Information Inventory*

- ◆ Develop a power map of decision makers, decisions they make and relationship with them relevant to monitoring and assessment activities
- ◆ For each water body identified in physical inventory, which has data/information, for what purpose, what timeline, what form and is it available?
- ◆ Who is actively acquiring what data in the basin, when, how, for what purpose and your relationship with them?

## PHYSICAL INVENTORY:

### Tier 1 - Watershed and Water body Identification

#### ◆ **Physical Inventory – Watershed Boundary, scale and scope**

A traditional definition of a watershed is the physical boundaries in which all surface and groundwater will drain or flow to one central area before combining with another “watershed” drainage area. Your scope or scale of interest may include multiple watersheds. If you have not yet, delineate the physical watershed boundary that applies for monitoring and assessment activities and in theory is the same as the watershed you are trying to affect or change. If your starting point is a list of water bodies, surface, ground or wetlands, then delineate at least the immediate watershed around each water body of interest.

One way to identify how many watersheds are in your geographic scope of interest is by stream order. The smallest watershed scale would most likely include a stream, from the source to where it flows into another stream or a lake or pond that might have multiple inlets. This is a stream order 1. When a stream order 1 meets another stream order 1, after their confluence their stream order increases by one to 2. If your stream order was 2, your watershed boundaries include two watersheds. When a stream order 2 meets another stream order 2, after their confluence their stream order increases by one to 3. This can continue up to a stream order of 12. The Mississippi River is a stream order 12 at its mouth when it flows into the ocean. Thus if your area of interest was around the mouth of the Mississippi, you would have to decide how far upstream to include in your work if you could not include the entire drainage area of all tributaries to the Mississippi. Small streams are categorized by orders 1-3, medium 4-6 and large 7-12. To conduct a stream order analyses, refer to *Step 2 Resource Guide*.

Watershed boundaries might be influenced by trans-trans-watershed diversions, water taken from your watershed and delivered to another watershed or visa-versa. In addition, there is the physical watershed boundary, identify the social, economic and political watershed boundaries. This could include communities, industries, and the like that use water in your watershed and/or are affected by the quality or quantity of water in your watershed.

There are other ways to determine your watershed boundary or the subpopulation you wish to assess.

#### ◆ **Physical Inventory – Map(s)**

Once you have determined your watershed(s) of focus, get map, make a map, but have a map. Maps are available from 1-800-USA-MAPS or local sporting goods stores and specialty map shops. Use this map as your reference map. Once you have it you will wonder how you lived without it.

You will generate or acquire many types of maps, but a visual of where you are focusing is very helpful. You put layers of information on this map as you discover it. Maps you obtain from others might have multiple layers of information relevant to your work. Create or look for maps with physical features, ecological or biological features and human features. Maps that illustrate sub-boundaries, man-made boundaries that cross over or through your watershed are important. They might include, jurisdictional

boundaries for cities, counties, tribal, federal and state agencies, water districts and other special districts. It might also be beneficial to look for growth plan boundaries, water supply and those type of lines. Know your area of interest, your watershed like the back of your hand.

◆ **Physical Inventory – Water bodies (surface, ground and wetlands)**

Identify all the surface, ground and or wetland water bodies in your watershed focus area and how they are connected to each other. Conversely you may have already identified the water bodies you are interested in. In this case, identify their watershed boundaries and then all the other water bodies within that boundary and how they are connected. List the major rivers, tributaries, streams, lakes, ponds, etc. that your group is interested in, regardless of whether you have any plans to monitor them.

For rivers, list the largest water body that it flows into (e.g. a larger river, lake, the ocean, etc.) before, or near, where it leaves your area of interest. Identify the source water for each river, within your area of interest of nearest to it. Classify the stream if appropriate, see next section for more details. Simple classification might be stream type, perennial, ephemeral or intermittent. You could further classify by ecological zones for example montane, transition and plains for example. Even more simply, cold, warm and transition stream.

For lakes or reservoirs, identify the source water(s), inlets and outlets. If you know of a lake classification scheme, classify them. Some classifications for streams will work for lakes as well.

For wetlands, list all water bodies that flow in or out of the wetland. Identify any lakes or reservoirs that are associated with the wetland. And if possible employ a wetlands classification scheme and classify the wetlands.

All waters and wetlands are connected within a watershed, directly or indirectly if by no other means than they drain the same area and land. Rivers are a continuum of biological, chemical and physical interactions in the water column, with the adjacent land and ground water. Lakes, reservoirs and wetlands are often a part of this continuum. Thus it is important to at least identify these connections with the water bodies of focus. It may very well prove relevant and significant for actions you might take.

◆ **Physical Inventory – Classification systems.**

You may have a need to subset or focus your inventory efforts. It might be useful to develop a management classification system or subset that can help prioritize and provide a focused context for an inventory and other planning and implementation components.

For example, you might be able to either classify water bodies within your geographic scope of interest by utilizing existing maps or identify features that influence and characterize your water bodies of interest. Often these characteristics have their own classification schemes. Any classification scheme is based on a purpose; know why you are classifying yourself or what the purpose was behind another classification scheme you might use:

√ Stream Classifications

- √ Lake and Reservoir Classifications
- √ Wetland Classifications

Other schemes exist based on use and other factors. See *Step 2 Resource Guide* for additional tools.

## PHYSICAL INVENTORY:

Tier 2 - Physical attributes within watershed and water body

### ◆ **Physical Inventory – Geological, ecological, physiological, regions**

Maps provide the types of rock and soil waters of interest flow over and through. This will influence chemical variables such as conductivity, salinity, hardness, alkalinity, pH, and other cations (positively charged ions such as calcium or a metal like cadmium) or anions (negatively charged ions such as sulfate and chloride). Physical characteristics of the rock and soil help provide insight with erosion and potential sedimentation above a natural rate. The chemistry in turn influences the type of aquatic organisms that can reside in the stream, lake, wetland and or riparian zone. Geologic features can also influence flow characteristics thus the distribution of aquatic organism, such as water falls. In addition, the rock and soils influence the type of ground water aquifers, wetlands and relationships between these two and surface waters.

### ◆ **Physical Inventory – Ecological or Vegetation zones or regions**

ecoregions or the like, are helpful for land use evaluations, land cover, wildlife distribution, wetland type identification and location. They primarily categorize the vegetation types on the landscape.

### ◆ **Physical Inventory – Precipitation and climate zones.**

Precipitation and climate influence many factors within a water ecosystem. Some examples include surface ground water relationships, erosion rates, water column chemistry, decomposition rates, what organisms can live here, biological patterns/behavior, flood and drought cycles to name a very few. You should at least get to know the precipitation type, frequency, duration and magnitude in your study area.

### ◆ **Physical Inventory – Biological (plants and animals).**

This can range from a simple species list to complex biological community structure, function and interactions. You may need to know who, besides humans, are benefiting from preservation or impacted by impairment. For fish for example, it may not be enough to know that a certain chemical variable has exceeded a standard, even if it is a biologically based standard. We may need to know more about the organisms “exposure” to the exceedance event. Where as it is valuable to know more about the exposure itself such as the duration, magnitude and frequency of the exposure, it also important to know as much about the organism responding to exposure. Categories of biological type of information might include:

- √ Species List: current, historical, eradicated, threatened and endangered, special concern, native, exotic/nuisance, introduced formal (stocking) or informal, economic value
- √ Life history and cycles (molting, spawning, ...)
- √ Behaviors (breeding, birthing, resting, and seasonal, ..)
- √ Habitat requirements (food, shelter and water)
- √ Community composition

- √ Community structure and function
- √ Type of animal (hydronomous, piciverous) or plant (hydrophyte, deciduous, etc.)

#### ◆ **Physical Inventory – Background and Baseline Chemistry**

If background, baseline or historic chemical or water quality data is important, identify your information needs. Inventory who has this information or might have it. If discover data exists that you could use, you need to evaluate that data against your monitoring and assessment, objectives and information needs of the targeted decision makers. You evaluate the monitoring reason and technical design for relevance, comparability, reliability, quality and quantity. This would include assessment of indicators, locations, duration, frequency and methods. *Step 2 Resource Guide* provides a quality check list to evaluate existing data. At this point, conduct this evaluation now or put on your to do list.

#### ◆ **Physical Inventory -Hydrology**

The hydrology of your site or water bodies can be very important. This might range from understanding frequency and duration of the 5, 10, 50 or 100 year events such as floods and droughts, base flow conditions, seasonal timing of flows and annual variations. It might include understanding how to water bodies mix their water. It might include understanding the connection between surface and ground water, between low flow and high flow seasons, between irrigation and return flow seasons. It may include retention time in a lake or wetland. You may need to know how much water is diluting a pollutant of concern when and where. It will be site and situation specific, but inventory how, when and where water moves through and stays in your water body of interest. Flow patterns define the rate and pathways for rainfall and snowmelt to circulate within water bodies. Flow is important as it is a critical component influencing the fate and transport of pollutants, their potential toxicity (effects of dilution for example), the energy budget of a water body, structure and function of habitats, and other condition assessment components.

#### ◆ **Physical Inventory - Physical habitat structure, function and composition**

Habitat structure, function and composition can apply to any component of your water body. Structurally, if your water body is a stream or river it could include lateral, longitudinal and horizontal habitat structures. Such as, upstream and downstream, in stream habitat, riparian zone, upland zone, and ground water. If your water body is a lake, it to might include receiving and outflow waters, stratification, substrate, lake habitat, riparian zone and upland zone. If your water body type is a wetland, it might include all the above but more horizontal detail into the substrate.

Composition and function further this inventory type to identifying what is there and is the is the habitat functioning to support its uses, physical, biological and chemical, human and wildlife?

#### ◆ **Physical Inventory – Land Ownership and Use**

**Land Ownership:** List the variety of land ownership in the area, develop your own categories or use others. Some might include:

- √ Public (type categories, Forest, City Park, etc.)

- √ Private
- √ Easements relevant to your water bodies

Obtain a map or make a map of land ownership in your watershed.

**Land Use:** List the different land use types, then list the percentage of the land area located in each type in the watershed for each water of interest. Use the following list: unmanaged forest, managed forest, cropland, and grazing land, urban, rural residential, industrial, and commercial. This information could be provided by the County Conservation District or County Planning Commission.

## PHYSICAL INVENTORY:

### Tier 3 - Water body specific

#### ◆ Physical Inventory – Water Uses

You can informally define uses and assign them to your water bodies based upon your own perceptions, those of stakeholders or community members. *Step 2 Resource Guide*. Or can employ your states Clean Water Act Designated Uses. See Clean Water Act Module for State Summaries in the Rocky Mountains. It is also valuable to conduct a uses, values and threats workshop, *Step 2 Resource Guide*.

#### ◆ Physical Inventory – Impact Features

Impact features includes all perceived, existing or potential human activities or features that might be pollutant sources or relevant to your monitoring and assessment activities. These are very helpful to put on your map. Your need or ability to quantify some of these will depend upon watershed size or area of interest size and possible scope of your work. They might include physical features such as:

- cities
- bridges
- land use
- water use
- diversion points
- roads (types)
- NPDES discharges
- land ownership
- water ownership
- discharge permits
- culverts
- % impervious surface
- residential densities
- epidemiology
- channelized stretches

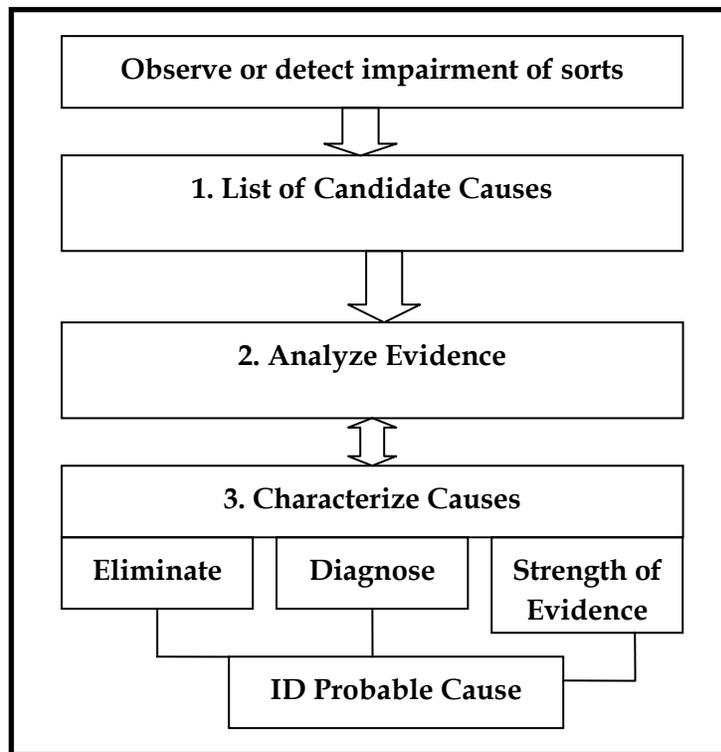
It is also valuable to conduct a uses, values and threats workshop, *Step 2 Resource Guide*.

#### ◆ Physical Inventory – Stressor ID

There are several informal and formal ways to identify stressors to your water bodies of interest. Stressors can be natural, such as floods and droughts or man-made such as channelization, chemical spills, or the introduction of invasive species. Stressors can be physical, chemical, biological or human. Stressors are also multidimensional and need to be viewed in both space and time. Through exposure, stressors cause some degree of disequilibrium for response organisms, usually humans, plants or animals.

The stressor identification processes can be a drive by survey (a regional general sense of stressors) or data quality intensive process (site specific discovery of the primary stressor). In general the stressor identification process entails reviewing existing information, forming possible stressor scenarios that might explain impairment, analyzing those scenarios (perhaps collecting data), and producing conclusions about which stressor(s) are causing the impairment. This might be the purpose for your monitoring activities. The accuracy of the identification will depend upon the quality of data and other information utilized. The conclusions can be translated into management actions and then the effectiveness of those management options can be monitored. The EPA has produced a Stressors Identification Guidance Document<sup>2</sup> and is in the process of putting databases and forms on line for public use. See excerpts of this Guidance Document in *Step 2 Resource Guide*.

This guidance illustrates that identifying the stressors is an iterative process, and even if you don't have all the data to accurately identify all the stressors, the exercise can help target future data collection efforts. The Stressor identification process, from the Guidance, can be characterized as follows:



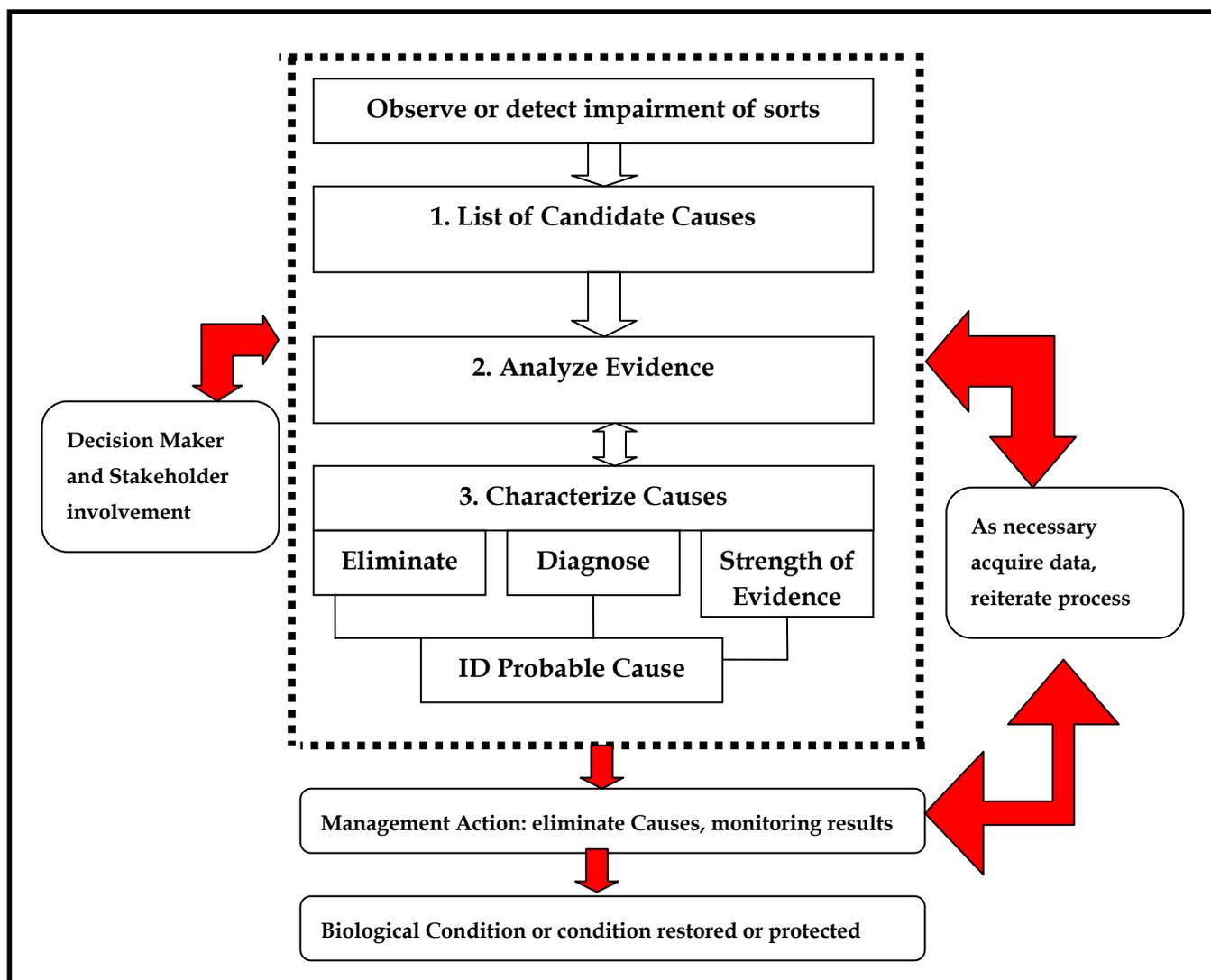
The core of stressor identification includes listing the 1) candidate causes (Chapter 2 of the Guidance), 2) analyze new and existing data to generate evidence for each candidate cause (Chapter 3) and 3) produce a causal characterization using the evidence generated in Step 2 to draw conclusions about the stressors that are most likely to have caused the impairment (Chapter 4 of Guidance).

The list of candidate causes is accomplished by carefully describing the effect that is prompting the analyses (e.g. absence of a fish species) and gathering available information on the situation and potential causes, conducting an inventory. Evidence may come from the case at hand, other similar situations, or knowledge of biological processes or mechanisms. The outputs of this initial step are a list of candidate cause and a conceptual model that shows potential cause and effect relationships.

The second step, analyzing evidence, involves analyzing the information related to each of the potential causes. Virtually everything that is known about an impaired aquatic ecosystem is potentially useful in this step. For example, data may come from chemical analyses of effluents, organisms, ambient waters, and sediments, toxicity tests of effluents, waters, and sediments, necropsies, biotic surveys, habitat analyses, hydrologic records, and biomarker analyses. These data do not in themselves, however, constitute evidence of causations. The investigator performing the analyses must organize the data in terms of associations that could support or refute proposed causal scenarios. Chapter 3 of the Guidance provides some assistance.

The third step, characterize causes, the investigator uses the evidence to eliminate, to diagnose, and to compare the strength of evidence in order to identify a probable cause. The input information includes a description of the effects to be explained, the set of potential causes, and the evidence relevant to the characterization. Evidence is brought in and analyzed as needed until sufficient confidence in the causal characterization is reached. In straightforward cases, the process may be completed in a linear fashion. In more complex cases, the causal characterization may require additional data or analyses, and is more iterative. All of this may be adding complexity you don't need or may provide a framework you find useful.

If you were to put the Stressor Identification process within the context of water quality management and data collection the Stressor Identification process might look like this:



Two tables are provided in *Step 2 Resource Guide*, from the Stressor Guidance Document lists the use of Stressor identification in various management type programs or monitoring and assessment activities. In general below are some potential watershed stressors or threats to help getting started.

Potential Watershed Stressors/Threats

| Pollution from specific locations ("Point sources")  | Resulting from sources such as:   |
|--|---|
| Acid mine drainage<br>Impoundments<br>Injection wells<br>Direct sewage discharge<br>Leaking underground storage tanks<br>Water withdrawals | Wastewater treatment plants<br>Food processing plants<br>Large animal feedlots<br>Pulp or paper producing plants<br>Power plants<br>Mines<br>Dams   |
| Pollution from land areas ("Non-point sources")  | Resulting from sources such as:   |
| Fertilizers<br>Herbicides and pesticides<br>Raw sewage<br>Exotic plant and animal species<br>Petroleum residues<br>Soil<br>Metals          | Lawns<br>Farms<br>Recreation and tourism<br>Underground and above ground storage tanks<br>Air pollution<br>Landfills<br>Unofficial or abandoned dump sites<br>Failing septic systems<br>Automobiles<br>Poor forestry practices<br>Paved surfaces<br>Construction sites<br>Removal of streamside vegetation<br>Stocking and planting of non-Native species |

◆ **Physical Inventory – Status and/or condition of water bodies.**

This section has you inventory what you might know about the current status of condition of waters you are interested in. This assessment can be informal, status assigned by your perceptions of those of stakeholders or community members. You might obtain this informal information from a meeting or survey. It is also valuable to conduct a uses, values and threats workshop, see *Step 2 Resource Guide*.

Conversely, a status or condition inventory could be a formal status given by a regulatory agencies such as, “Blue Lake is attaining the designated uses for cold water fishery and drinking water but not recreational use”.

For each of your water bodies of interest, take a first cut at determining the status of your water bodies of interest. Provide definitions. Below is an example of how you might capture both types of status inventories

**Formal Status. How to Capture the Status of Water bodies According to Your State’s (305b) Assessment**

The fifth workbook in this series is a compilation of how the Clean Water Act is implemented in the Rocky Mountain States. Included in this summary is the description, location and an example of each states 305b Assessment Reports. Each state reports to EPA and Congress every two years with a list of all the waters in the state, and the extent to which they support their designated uses under the state water quality standards. As part of this process, each state develops a list of all its waters and delineates whether they fully or partially support, or do not support their protected uses as described in the “305(b)” report and water body list.

Straight from Colorado’s 2004 305b report as an example of what is in such a report as a “formal” status of your water body:

"The 2004 305(b) Update provides a current and accurate assessment of all surface waters of the state which have been assessed in the past six years. It also reports the extent of which these waters provide protection for the propagation of aquatic life ("fishable") and primary contact recreation ("swim able") in and on the water.

In the past, this report has also extensively reported on the water pollution control programs and descriptions of the nonpoint source pollution control programs, ground water and drinking water programs. Most of this information will only be referenced in the 2004 Update in efforts to streamline the State's resources to produce various reports each year. The 2004 305(b) Update is a more efficient document, which intends to give the reader not only the most recent assessment information of waters of the State of Colorado, but a variety of references where information can be found."

An example of a list of streams for Colorado includes:

## Appendix B: Designated Use Support Summary

| Key:<br>WBID = Water Body Identification, FS = Fully Supporting, NS = Not Supporting, NA = Not Assessed, IR = Integrated Reporting (Categories defined in text) |   |              |      |  |        |         |             |
|---|---|--------------|------|--|--------|---------|-------------|
| WBID  | Segment Name  | Segment Size | Date | Use Support - Designated Uses  | Causes | Sources | IR Category |
| COGUUG14  | Gunnison R. - Confluence of East and Taylor Rivers to Blue Mesa Reservoir                           | 24 miles     | 2002 | FS - Aquatic Life Cold 1<br>FS - Recreation 1<br>FS - Water Supply<br>FS - Agriculture |        |         | 1           |
| COGUUG15  | Gunnison River tributaries from the confluence of the East and Taylor Rivers to Blue Mesa Reservoir | 302 miles    | 2002 | FS - Aquatic Life Cold 2<br>FS - Recreation 2<br>FS - Water Supply<br>NA - Agriculture |        |         | 2           |
| COGUUG16  | Ohio Creek  | 157 miles    | 2002 | FS - Aquatic Life Cold 1<br>FS - Recreation 2<br>FS - Water Supply<br>FS - Agriculture |        |         | 1           |
| COGUUG17  | Antelope Creek  | 31 miles     | 2000 | FS - Aquatic Life Cold 2<br>FS - Recreation 2<br>FS - Water Supply<br>FS - Agriculture |        |         | 1           |
| COGUUG18  | Tomichi Creek   | 67 miles     | 2000 | FS - Aquatic Life Cold 1<br>FS - Recreation 2<br>FS - Water Supply<br>FS - Agriculture |        |         | 1           |
| COGUUG19  | Tomichi Creek tributaries   | 315 miles    | 2002 | FS - Aquatic Life Cold 1<br>FS - Recreation 2<br>FS - Water Supply<br>FS - Agriculture |        |         | 1           |
| COGUUG20  | Indian Creek  | 3 miles      | 2002 | FS - Aquatic Life Cold 1<br>FS - Recreation 1<br>FS - Agriculture                      |        |         | 1           |

This example from Colorado lists the water body identification code (WBID), the water body segment description, the size of the segment, the data of the assessment, the status of use support designated in each state, any causes, sources and the integrated reporting number 1-5. This is EPA's method of being able to compare different state assessment across states. The Integrated reported numbers associated with each stream are:

- 1=all uses are being met and all have been assessed
- 2=uses that have been assessed are being met, not all uses are assessed
- 3=impairment suspected, uncertainty surrounding it, put on monitoring and evaluation list
- 4=three subsets, a, b and c, describing different states of impairment or knowledge re:impairment, known and TMDL is completed 4a, known and other means of restoration employed 4b, known but other uncertainty exists goes on monitoring and evaluation list.
- 5=impairment known and identified, on 303(d) impaired stream list for TMDL development

These reports usually describe assessments and status in number of ways, by water body, watershed, pollutants, impaired streams, streams with TMDL's developed, streams with nonpoint source projects and the like. They are a wealth of information for an inventory starting place.

Impaired waters that do not meet the water quality standards appear on the "303(d)" list. For these waters, "Remediation Plans" must be developed in which pollution loading is allocated among various sources through "total maximum daily loads" or TMDL's. Not all waters that are listed as impaired on the 305(b) list will necessarily appear on the 303(d) list. There are three reasons why this might occur: (1) A pollutant as defined by the Clean Water Act does not cause the impairment. The state does not place these waters on the list since there is no pollutant to allocate through the TMDL process. (2) Impairments are being, or will be, addressed through existing enforcement and compliance pollution control efforts. (3) The water body already has an EPA-approved TMDL developed for identified causes of impairment.

You would make a table, listing down the left side all the water bodies of interest. Across the top are the following categories. List or check the appropriate information for each water body type and status. This table prompts you to list your waters of interest and various aspects of their status under the water quality standards. Put any or all of this information on your map or make a condition map. The information in this table comes out of three sources:

- 1) The State Water Quality Standards
- 2) Current Section 303(d) list (State environmental department); and
- 3) Your own experience.

**1) Water Uses Protected:** Define what uses you are employing (your own or the states), then identify the protected uses of the water – such as recreation, water supply and aquatic life – that are to be achieved and protected. You should find a list of official designated uses in your state's water quality standards list.

**2) Actual Uses and Values:** Based on your experience, list the uses that are actually occurring in each water of interest. Here you don't need to limit yourself to the above list of uses. List any types of water uses (e.g. sightseeing, picnicking) and values (e.g. aesthetics, historical) that you can think of or from community workshops you can hold (see below).

**3) Waters Assessed:** Check the water quality assessment maps by your states, or their assessment list to see whether your waters have been assessed. If not, you might want to flag these waters for your own monitoring needs.

**4) Uses Supported:** Check the water quality assessment maps or their 305(b), 303(d) or other lists to see whether your waters support their designated uses. If not, these waters are considered *impaired*.

**5) NPS Pollution:** Check the water quality assessment maps or your states Section 319 Non Point Source Program to see whether nonpoint source (NPS) pollution is present in your waters. Often this is in report format.

**6) Source of Impairment:** For impaired waters, check the 303(d) list to see the activities that are causing the impairment. List these here. If they provide the source of data, list the source.

**7) Cause of Impairment:** For impaired waters, check the 303(d) list to see the contaminant(s) which are causing the impairment. List these here. If they provide the source of data, list the source.

**8) Known Problems:** If you know of problem areas that are not part of the above inventory, lists these here. Include a description of the problem and your indicators that there is a problem.

**9) Conflicts, Known Threats or Issues:** If you know of conflicts among user groups or threats to the protected uses or resource, list these here. Describe the conflict or threat and your indicators and source. See Side Bar.

**10) Known Efforts to Address Problems:** If you know of any efforts to address the problems listed in columns 3 or 4 of this table, list them here. Note especially if there are any remediation plans or TMDLs in process.

**Informal Status. Develop one, two or combinations of identifiers for your water bodies of interest and their condition or status.**

For the purpose of monitoring and assessment and resulting restoration or protection activities, for example, develop condition or status "labels" that help your work. Define these categories as specific as possible. It is plausible and credible to employ categories that states use for Clean Water Act implementation even if you have no desire or intention of participating in Clean Water Act decisions. Don't be afraid to use the science developed for that process.

For example a water body categorization based on preservation and restoration:

1. Sensitive
2. High quality
3. Impacted
4. Restorable
5. Unknown

Combine with major land use and land type:

1. Urban
2. Residential high density
3. Residential low density
4. Industrial
5. Rural ranching
6. Rural dry land farming
7. Rural irrigation farming
8. Forest or desert
9. Wetland type(s)
10. Unknown

Combined with major water uses you are interested in:

1. Drinking water
2. Recreation
3. Fishery
4. Agricultural water
5. Unknown

PEOPLE INVENTORY:

Tier 1 - Historical and Cultural People Inventory within Watershed

◆ **People Inventory – Historical and Cultural**

*Who are the cultural and historical peoples in the watershed? What are their perspectives and stories? What is the historical use of the land and waters? How do these compare with today? Where are the cultural and historical sites of significance?*

*“Culture is like a tree. If the green branches – a people’s language, legends, customs – are carelessly chopped off, then the roots that bind people to their place on earth and to each other also begin to wither. The wind and rain and the elements carry the topsoil away; the land becomes a desert.”*

- Mariano Lopez, Tzotzil Indian, Chamula, Chiapas, Mexico (Western 1994).

Culture encompasses the wide range of shared and distinct values, beliefs, attitudes, behaviors, and assumptions that people have about themselves and others. We are all influenced at some level by our family’s culture and the cultures of the places we have lived and do live.

“Ethnic history is like a bow and arrow. The farther back you pull the bow string, the farther the arrow flies. The same is true with historical vision: the farther back you look, the farther you can see into the future. If you pull the bowstring back only a little, the arrow only goes forward a short way. The same with history: if you only look back a short distance, your vision into the future is equally short.” Navajo Teacher (Western 1994).

If we are connect with and listen to the stories of the past, perhaps we can turn them into fairytales for the future, because we have the courage to listen and learn and try something different. History has a very important role in achieving our vision, if our vision requires “changing” people to get there. We have history to learn from and today, this minute to act on in order to change the future.

The following table illustrates the potential importance of reviewing changes in these systems from historic conditions and uses.

**Cultural Ecosystem Story**

A "Cultural Ecosystem Story" could serve as your primary source of culturally specific information about your watershed. Every community has developed its own system for understanding and relating to its environment. The system is often stored, practiced and passed on through the customs, stories, and activities of indigenous people and their community. One or more listeners collect this "Story" by talking with members of the tribe and preserving their accounts. It may range from a personal interview of a few purposefully selected community members to interviewing many individuals and extensively documenting the uses of many resources over time. For a watershed assessment, the listener could attempt to seek the knowledge of those in the community whose activities depend on certain resources in the watershed. These resources may include clean free flowing water for spiritual cleansing, certain wetland plants used by basket weavers or rivers that provide suitable spawning habitat for salmon. The longer a community member has observed and directly interacted with one or more relations, the more important that person's knowledge will become to the "Story."

**Table 1 – Changes in hydrologic flow, water quality, wetland area, and species viability in U.S. rivers, lakes, and wetlands since Euro-American settlement**

| U.S. Freshwater Resources   | Pre-settlement Condition | Current Conditions                                  | Source                     |
|---|--------------------------|---|----------------------------|
| Undammed rivers (in 48 contiguous states)   | 5.1 million km           | 4.7 million km                                      | Echeverria et al. 1989     |
| Free-flowing rivers that qualify for wild and scenic status (in 48 contiguous states)   | 5.1 million km           | 0.0001 million km                                   | USDOI 1982                 |
| Number of dams > 2m   | 0                        | 75,000  | CEQ 1995                   |
| Volume of water diverted from surface waters  | 0                        | 10 million m <sup>3</sup> day <sup>-1</sup> (1985)  | Solley et al. 1998         |
| Total daily U.S. water use  | Unknown                  | 1.5 million m <sup>3</sup> day <sup>-1</sup> (1985) | Solley et al. 1998         |
| Sediment inputs to reservoirs   | Not applicable           | 1,200 million m <sup>3</sup> /year                  | Stallard 1998              |
| River water quality* (1.1 million km surveyed)  | Unimpaired               | 402,000 km impaired*                                | EPA 1998                   |
| Lake water quality* (6.8 million ha surveyed)   | Unimpaired               | 2.7 million ha impaired*                            | EPA 1998                   |
| Wetland acreage (in 48 contiguous states)   | 87 million ha            | 35 million ha                                       | Van der Leeden et al. 1990 |
| Number of native freshwater fish species  | 822 species              | 202 imperiled or extinct                            | Stein and Flack 1997       |
| Number of native freshwater mussel species  | 305 species              | 157 imperiled or extinct                            | Stein and Flack 1997       |
| Number of native crayfish species   | 330 species              | 111 imperiled or extinct                            | Stein and Flack 1997       |
| Number of native amphibian species  | 242 species              | 64 imperiled or extinct                             | Stein and Flack 1997       |
| *Only 19% (1,116,500 km) of total river km in U.S. were surveyed out of a total 5,792,400 km. Only 40% (6.8 million ha) of total lake area (16.9 million ha) were surveyed. |                          |   |                            |

**Source: *Issues in Ecology: Number 10, Winter 2003.***

Some strategies to obtain historical or cultural information include museums, libraries, educational institutions, historians, city or county archives, historical societies, and interviewing elders or relatives of historical residents.

◆ **People Inventory – Current**

*Who are the people that live in the watershed today?* What do you know about them and what is your relationship to them? This is much more important that we often give credit too. We perform watershed assessments often to develop programs that manage how people can use the resource. If we understand the people using the resource, the problem might become the solution. We also learn their values, perceptions, use, beliefs and we might discovery more solutions, more resources, more possibilities, more avenues to achieve our visions.

A people inventory is wide open but can include:

- cultural mix
- rentals vs. owned homes
- incomes
- housing types
- community organizations
- birthrates, death rates
- ethnicity
- values
- employment
- educational system
- epidemiology
- age composition
- interests
- unemployment
- values

Another perspective might be to conduct a community characteristics inventory. This would include such items as<sup>3</sup>:

- community capacity and activism
- demographics
- economic conditions/employment
- governance
- local identity
- natural resources/landscape
- public safety and health
- Community boundaries
- community interaction/info flow
- education
- environmental awareness/values
- infrastructure/public service
- local leisure and recreation
- property ownership/planning/management

The value of a knowing the characteristics of your community can provide avenues, resources and strategies for assessment implementation and more importantly action you may design and implement as a result of the assessment. You give synergy the opportunity to expand if you involve and understand the communities, cultures and people within your watershed.

There are many community and people inventory assessment tools, some of which include<sup>3</sup>:

- background research
- content analyses
- focus groups
- maps and geographic research
- observation
- surveys and polls
- social mapping (assets, cognitive, concept, social network)
- census data research
- environmental values typology
- interviews
- meetings
- regional economic data research
- visual methods

#### ◆ **People Inventory - Significant Social, Political or Cultural Considerations**

This may or may not be important depending upon your community and scope of work. If your watershed is composed of tribal land, you may want to evaluate, inventory and relationship build with the tribes. Different cultures have different uses and perspectives for water and possibly restoration and protection efforts for example. If the communities in your watershed are economically strapped, majority low income or visa versa, this may or may not play an important role for how you strategize change. Take a minute and consider the social, political and cultural aspects of your watershed and water bodies of interest.

PEOPLE INVENTORY:

Tier 2 – Relationship Inventory

◆ **People Inventory - Identification of Values, uses, perception and perceived threats/conditions**

In a perception or value survey your goal is to be able to identify, define and or quantify the public's perception or value of a certain water body. What is the public's perception of quality, use, condition, health, etc. Why you want this? Perhaps there was a historic toxic waste or spill from some event or plant that is no longer physically there, but the legend of water being "so bad that..." still lingers. The economic development board is working on a plan to increase recreation, bike path, etc. and view the public's perception an obstacle.

The key is to clarify what perceptions and values you are trying to assess and why. Identify who you need to understand and be creative in ways to reach them. If you can characterize groups, settings and opportunities, demands for activities, settings and experiences, variations in perception, use and values you can develop strategies to achieve your outcomes and watershed vision.

Conversely a value survey is one that attempts to identify the values of a targeted public, user group, stakeholder, community, or the like. You need to play with language to make sure your biases and definitions are clear and you are getting the answers you desire from well thought out questions. It is common and valuable to pilot your surveys and have folks tell you what they think you are asking and tweak accordingly. The purpose for conducting and value's survey ranges, but it may be important and significant for the success of your work to align organizational values and project goals with community values. It may provide you with a gage on how much support or lack of support there is, which may help you leverage resources or tell you might need to conduct more education effort. The key is to clarify what perceptions you are trying to assess and why. Identify who you need to understand and be creative in ways to reach them.

Usually, the results from a perception or value survey are used to determine what type of monitoring or education may be needed and what and who to focus these efforts on. Implementation of these surveys vary, from mailings only, mailings with phone interviews, phone interviews, presentation/survey delivery to specific groups, handed out after and event or experience, combinations or other mechanisms. There is no one manner.

To investigate how people are using the river several techniques are effective including focus groups in neighborhoods and by topic, on-site surveys of recreational or other users, face-to-face interviews with resource experts, target audiences, suitability analyses to determine how existing land uses could provide recreation or other use opportunities, telephone survey of residents, and or mail surveys to target audiences. The bottom line is find ways to ask and observe how the resource is has been, is or could be used<sup>4</sup>.

Target audiences should be subset carefully to understand differences in how you would contact them and their perspective. Examples for the Chicago recreation use project<sup>4</sup> included subsets of nearby

residents, on-site users, resource experts, corridor residents, city residents, an ethnic neighborhood, and water user groups such as canoeists, kayakers and rowers. They requested the same information, knowledge of the place, identification of special places and their values of the place, however the mechanism and approach was different for these audiences.

See Perception Surveys or Value Surveys and Mapping *Step 2 Resource Guide*. It is also valuable to conduct a uses, values and threats workshop, *Step 2 Resource Guide*. Also see the Green Mapping System as a tool charting the ecologically significant places, projects and organizations in their home communities-as defined by the people who live in the watershed or use the water body of interest. The concept was developed to promote urban environmental health and awareness. The maps are as informal as hand drawn on newsprint or brochures available and chamber of commerce's, *Step 2 Resource Guide*.

### ◆ People Inventory - Identification of Stakeholders

Stakeholder: "A person / organization with a legitimate, vested interest in the outcome of an undertaking". Some examples include citizens, governing bodies, political parties, politicians, regulators, taxpayers, suppliers, special interest groups, employees, financial community, businesses, service recipients, medical community, competitors, land owners, media, community organizations or recreation community.

Identify the various stakeholders in your basin. You may have different stakeholders for different aspects of this plan and the results. For example to develop a vision might involve a different set of stakeholders than those you engage to determine monitoring and assessments sites. It may or may not be appropriate to involve all stakeholders all the time. These are decisions you will need to trust with your own judgment. *Step 2 Resource Guide*, list in Center for Watershed Protection<sup>1</sup>.

Ideally you want to engage stakeholders, next inform them and at a minimum identify key stakeholders, they are the life blood of any project. They may include your constituents, staff, and board, funders, similar organizations, beneficiaries of your work, targeted decision makers, community members at large or youth. Think broad, think out of the box to identify stakeholders.

Once you have identified your key stakeholders, develop a relationship and rapport with them. Clarify key, typically key stakeholders are those essential to the success of the watershed vision, watershed assessment and monitoring program in this case. Your goal is to connect with what their needs, desires and wants are and why. What are their priorities? You want to establish trust. Think this through, so that you are sincere and genuine with them and evaluate if you can meet their needs and priorities, you may not and honesty flies in the path of effort, so be honest about your abilities.

After getting to know your key stakeholders the next rule is never, ever forget them! Remember who they are, their concerns, their priorities, annoy them at your risk and ignore them at your peril. There are many stakeholder resource guides available, an example of one process follows, but use a process that makes sense for your situation. Contact others and see what process they used and how it served them.

### **Eight Step Stakeholder Analyses:**

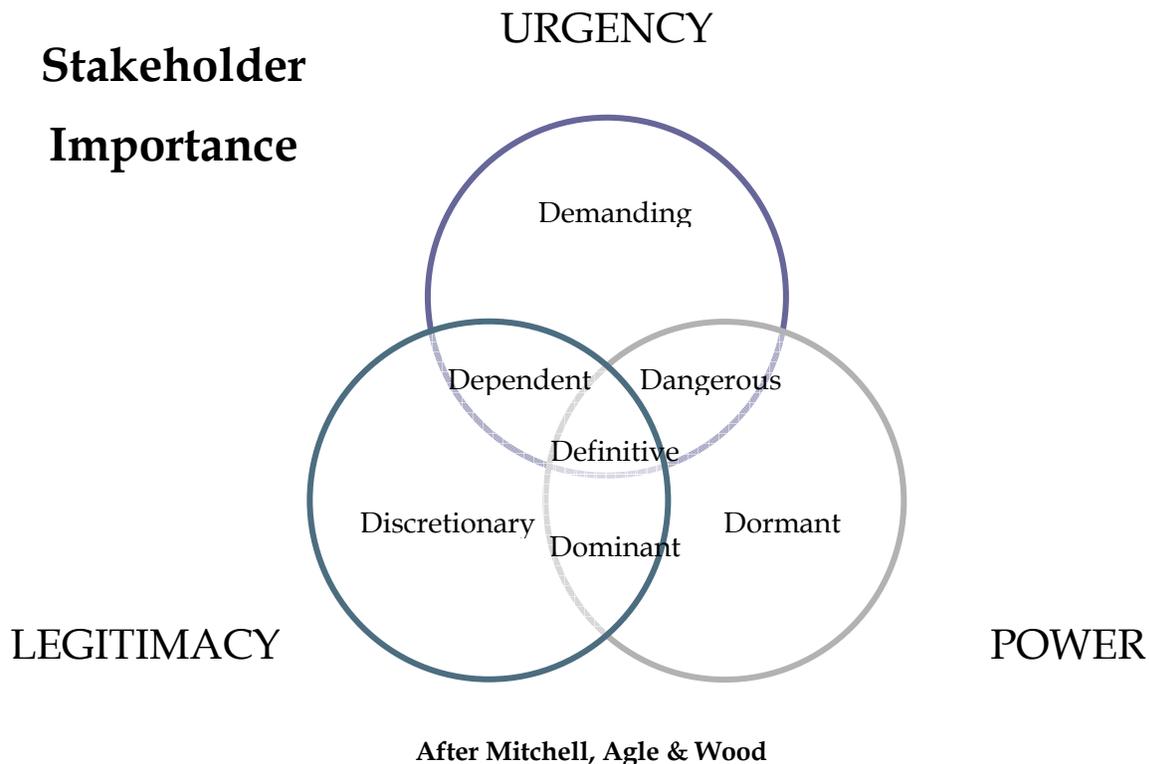
1. Identify Critical Stakeholders-review their mandates, check lists, contacts, comment file, scenarios, staff, program areas
2. Assess Stakeholder Interests & Criteria-initial subjective assessment, top 3 concerns/desires, top 3 success criteria, rank organization against criteria on scale of 1-10, keep it simple silly.
3. Rank Stakeholders in Importance-rank order versus clout, internal and external
4. Evaluate Stakeholders' Ratings of Organization-Score Probable Stakeholder Rating of organization versus criteria on scale of 1-10
5. Interview Key Stakeholders-meet face to face and discuss organization's challenges and issues, have opportunities for them participate in the organization if appropriate-or ask them how they would like to so you might be able create opportunity
6. Revise Assessment of Stakeholder Concerns and Criteria-synthesize results of interviews and revise initial assessments
7. Classify Stakeholders-organize stakeholders by a meaningful established typology
8. Review Implications and develop approach-design and tailor appropriate approach for each stakeholder

Who should be at your table? Stakeholders have one or more of three critical attributes:

- √ Power - control of resource, clout, information, knowledge, access, etc.
- √ Legitimacy - valid interest, credibility, legal, historical, etc.
- √ Urgency - immediacy, critical impacts

Take these attributes and define three classes of Stakeholders

- ◆ **Definitive Stakeholder**, if they have all three attributes, you must consider them
- ◆ **Secondary Stakeholder**, if they have any two attributes, consider by priority
  - "dominant"=power + legitimacy
  - "dependent"=urgency + legitimacy
  - "dangerous"=urgency + power
- ◆ **Tertiary Stakeholder**, if they have any one, less important, but still review
  - "dormant"=solely powerful
  - "discretionary"=- solely legitimate
  - "demanding"=solely urgent



Each Stakeholder type has a different importance, need and style and thus needs to be treated differently. You don't want to label anyone per say, as much as you want to be focused and strategic. Any involvement opportunities for your stakeholders must be meaningful and sincere. Definitive Stakeholder are the most important and must be actively involved, at the table, engaged and participating. Create opportunities together.

Secondary Stakeholders dominant types are influential, solicit their counsel, they should be at the table. Dependent types are reliant on others and seek support. Dangerous types can be coercive, potentially disruptive, listen and watch and be prepared to respond.

Tertiary Stakeholder dormant types are unlikely to get involved, might switch suddenly, and monitor their decisions and behavior. Discretionary types are not critically important, listen to them. Demanding types might be persistent nags, avoid wasting your time and theirs. No harm is done truly listening to everyone, until they feel heard and understood (which is not agreement), at least once.

#### ◆ People Inventory - Identification of Partnerships

Take a moment and identify who it might make sense to develop partnerships with in your monitoring and assessment efforts. What is your relationship with them? Think out of the box, you can partner on

a variety of aspects funding, labor, equipment, or different components, data gathering, interpretation, management, reporting or stakeholder development.

“ We see it like this, it is as if we are all in a canoe traveling through time. If someone begins to make a fire in their part of the canoe...it will affect us all. And it is the responsibility of each person in the canoe to ensure that it is not destroyed.” Ailton Krenak, Union of Indigenous Nations in Brazil (Solo 1992).

### ◆ **People Inventory - Relevant Statutes and Programs**

What are federal, state and local statutes and programs of relevance? A list of possible Federal Statutes mandated to states include:

#### **Clean Water Act**

- ◆ Non point Source Program (Section 319)
- ◆ Wetlands Program (Section 404)
- ◆ Total Maximum Daily Loads (305(b) Reports and 303(d) Impaired Lists)
- ◆ Water Quality Standards Program
- ◆ National Pollutant Discharge Elimination System (NPDES)
- ◆ Bioassessment and Biocriteria
- ◆ Monitoring and Assessment
- ◆ Storm Water Regulations (phase 1 and 2 cities and activities)
- ◆ Capitalization Grants for State Revolving Funds (CWSRF's)

#### **Safe Drinking Water Act**

- ◆ Drinking Water Program
- ◆ Source Water Protection Program
- ◆ Underground Injection Control Program

#### **National Environmental Policy Act (NEPA)**

- ◆ Environmental Impact Statements for Federal Decisions
- ◆ Section 309 Clean Air Act

#### **Superfund**

- ◆ Investigation and cleanup of uncontrolled hazardous waste in large quantities

#### **Brownsfields Program**

- ◆ Contaminated sites that have or are perceived to have active potential for redevelopment or reuse

#### **Resource Conservation and Recovery Act (RCRA)**

- ◆ Ensures hazardous waste is properly managed from generation to disposal or destruction

#### **Clean Air Act**

- ◆ Air and radiation provisions of the Act

#### **Ecosystems Protection Program**

- ◆ Cross coordination of staff that is needed to help communities access appropriate resources and programs to achieve broad watershed protection goals

#### **Source Water/Ground Water Team**

- ◆ Dedicated to protection of region's groundwater

#### **Ecosystem Stewardship Team**

- ◆ Community based approach to environmental protection, goal driven rather than pollution driven in protecting, restoring, and sustaining healthy human and ecological communities

#### **Mining Team**

- ◆ Expertise in hard rock mining for watershed groups

## PEOPLE INVENTORY:

### Tier 3 – Information Inventory

#### ◆ **People Inventory – Develop a power map of decision makers, decisions they make and relationship with them relevant to monitoring and assessment activities**

This may or may not be necessary for your assessment. It will depend on what you are assessing, the scale and scope and the history behind the project and your organization. If you do not know who makes major decisions and what those decisions are, this exercise can be very helpful in determining who to target, how and why. One possible result is a decision to change who you decide to target. *If you completed Step 1, this is already started and perhaps completed.*

There are many methods to conduct this type of inventory. One is to simply state a particular decision, vision or outcome and list the individuals or organizations that have power and influence over that decision. Then you assess your relationship with them, what do you need to do, or even more basic who should you target and why?

A visual process that is similar to a list is called power mapping. The more specific your question or desired decision, the more precise power mapping is. Thus, it might be more useful later in the process; it depends on your goals. Power mapping is a term for what you do when you put your desired decision in the center of a piece of paper. Draw multiple rings around that circle, like drawing a target. The close rings imply a particular organization or individual has a lot of power and influence over the decision in the center. The further out the rings are, the less power and influence folks have. Then you brainstorm all the players that have power and influence over the decision and place them on the target, be concrete about why they have power and influence, separating perceptions and evaluations with measurable power, such as “it is their job to implement the land use code”, or “they own the land”.

Next you assess your relationship with each of the listed decision makers. Do you know them? Work with them? Already target them? Afraid of them? No idea how to even contact them? For all the folks you do target, how much of your program effort and resources are going to which sector. Folks often discover they are spending a lot of resources on entities in the outer rings.

You can leave this general power map and come back when you have your monitoring reason and objectives defined. It becomes a resource. Or you can utilize this power map to strategize action plans on who you will target and how. Power maps are very effective tools for activities such as political or educational campaigns, specific behavior changes such as getting teenagers to use birth control or getting new development to install water efficient toilets. The final step is to dig deep into each decision maker and discover what makes them tick and develop a strategy to influence them from this point.

One reason to conduct a power map in the inventory phase, prior to visioning and defining desired outcomes and associated activities, is that this inventory will provide a first cut at all possible decision makers you might target for all possible activities you might conduct, including monitoring but not exclusive to monitoring.

◆ **People Inventory – For each water body identified in physical inventory, who has data/information, for what purpose, what timeline, what form and is it available?**

You have identified general or specific monitoring and assessment activities or goals. You have listed the water bodies of interest. Now be curious about others' monitoring and assessments in a manner that you are trying to glean from them why they are assessing what they are assessing. A good starting point is with the information needs list you generated. You can also use the physical and other inventories as a starting point, check off list. Who might have some of the inventory information you might need, maps for example, or a list of water bodies and their uses. The *California Watershed Assessment Manual Draft*<sup>5</sup>, [http://cwam.ucdavis.edu/Manual\\_chapters.htm](http://cwam.ucdavis.edu/Manual_chapters.htm), Chapter 4, provides more information and tips on collecting and organizing existing data.

In any case, when you acquire others data you should always ask why it was collected, what questions were they asking, what methods were employed and did the data answer the questions and how do they know? If they cannot answer all of these, that might be more valuable than the information itself.

This can be very important. This helps you evaluate what you are doing and why. The data might provide the benchmark for your data, it might validate your results, it might provide a necessary ingredient for interpretation. It might reduce duplication and redundancy. The reasons why justify the resources expended to answer this question.

◆ **People Inventory – Who is actively acquiring what data in the basin, when, how, for what purpose and your relationship with them?**

As with legacy or existing data, ask the question who in the basin is acquiring what data, why, how, what are their questions, how will they know if they are answered? Again, if they cannot answer all of these, that might be more valuable than the information itself. It may also be important to evaluate your relationship to them and how existing or future goals might overlap or how your organizations might collaborate to reduce duplication, increase credibility and effectiveness.

What Will You Do With the Inventory? Prioritization and Planned Action.

Identify and prioritize physical inventory needs. Identify and prioritize people inventory needs. Develop an action plan, with task, time table, responsibility and deadline. This action plan will be implemented concurrent to your monitoring and assessment activities because inventories are dynamic and never completed.

Case Study 1:

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Case Study 2:

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### References:

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- <sup>1</sup> *Watershed Assessment Manual*, Center for Watershed Protection, cwp.org, many other publications such as *The Practice of Watershed Protection*, *Stormwater BMP Design for Cold Climates*, *Site Planning for Urban Stream Protection* and over seven watershed plan examples, focus is primarily on urban streams.
- <sup>2</sup> *Stressors Identification Guidance Document*, 2000, USEPA (EPA 822-B-00-025), Office of Water, Washington, D.C.
- <sup>3</sup> *Community Culture and the Environment*, A Guide to Understanding a Sense of Place, 2002, USEPA (EPA 842-B-01-003), Office of Water, Washington D.C.
- <sup>4</sup> *People and the River, Perception and Use of Chicago Waterways for Recreation*, Chicago Rivers Demonstration Project Report, Gobster P. and Lynne Westphal Editors, National Park Service, Rivers, Trails and Conservation Assistance Program. 1998.
- <sup>5</sup> *California Watershed Assessment Manual Draft*, [http://cwam.ucdavis.edu/Manual\\_chapters.htm](http://cwam.ucdavis.edu/Manual_chapters.htm), Chapter 3 and 4.
- <sup>6</sup> *Keep It Clean, Water Quality Campaign Communications Tool Kit*, designed to modify for your needs, [www.npscolorado.com](http://www.npscolorado.com) or contact a Rocky Mountain Watershed Network member.
7. Watershed Basics, <http://ag.arizona.edu/oals/watershed/basics.html> (what is WS, riparian zone, surface/ground, erosion, quality, conservation, harvesting, soil and fire and their role in watershed, management, case study)

### Resources:

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*Contents in Phase 1, Step 2 Resource Guide:::*

1. How to determine stream order
2. How to create focus or management areas that might warrant similar effort for water body types, segments of specific water bodies, water uses, or on your own categories-make them up to serve your needs.
3. Stressor Identification role in various monitoring and assessment activities and management programs.
4. Uses, values, Threats workshop.
5. Perception Survey or Values Survey/mapping
6. Green Mapping
7. Existing Data Quality Check List, see *Step 5 Resource Guide*.
8. Recommended Watershed Terminology, from [http://watershed.org/news/fall\\_94/terminology.html](http://watershed.org/news/fall_94/terminology.html)

## RESOURCE GUIDE

### **Step 2: Scope Inventory (Physical, People, Information)**

#### **Contents**

1. How to determine stream order
2. How to create focus or management areas that might warrant similar effort for water body types, segments of specific water bodies, water uses or on your own categories.
3. Stressor Identification role in various monitoring and assessment activities and management programs.
4. Uses, values, Threats workshop.
5. Perception Survey or Values Survey/mapping.
6. Green Mapping.
7. Quality check list for using others data, see *Step 5 Resource Guide*.

#### **How to Determine Stream Order**

One way to identify how many watersheds are in your geographic scope of interest is by stream order. The smallest watershed scale would most likely include a stream, from the source to where it flows into another stream or a lake or pond that might have multiple inlets. This is a stream order 1. When a stream order 1 meets another stream order 1, after their confluence their stream order increases by one to 2. If your stream order was 2, your watershed boundaries include two watersheds. When a stream order 2 meets another stream order 2, after their confluence their stream order increases by one to 3. This can continue up to a stream order of 12. The Mississippi River is a stream order 12 at its mouth when it flows into the ocean. Thus if your area of interest was around the mouth of the Mississippi, you would have to decide how far upstream to include in your work if you could not include the entire drainage area of all tributaries to the Mississippi. Small streams are categorized by orders 1-3, medium 4-6 and large 7-12.

Above is repeat

If a stream order 1 flows into a stream order 2 or greater, the stream below the confluence will remain the higher number. The rule is like numbers much meet in order for stream order to increase by one.

#### **STREAM ORDER VISUAL HERE**

EDIT AND INCLUDE INSTRUCTIONS AND TIPS WITH MAPS, exercise, and relate to RCC.

#### **Create management categories or focus areas that might warrant similar effort for water body types or segments of specific water bodies.**

Based on your inventory and research, lump waterbodies of interest into categories, for example lump based on preservation and restoration:

1. Sensitive
2. High quality
3. Impacted
4. Restorable
5. Unknown

Or lump based on major land use and land type:

6. Urban
7. Residential high density
8. Residential low density
9. Industrial
10. Rural ranching
11. Rural dry land farming
12. Rural irrigation farming
13. Forest or desert
14. Wetland type(s)
15. Unknown

Or lump based on major water uses you are interested in:

16. Drinking water
17. Recreation
18. Fishery
19. Agricultural water
20. Unknown

You may have already determined the waterbody type, say wetland or streams, or a certain subset of types for your study. If you do this type of lumping to assist you in setting priorities, focusing on certain areas or issues, we strongly encourage you to DEFINE all subcategories however meaningful and technical. You want to be clear how you are “labeling” a body of water and why, for you, your staff, your constituency, stakeholders and decision makers. It might be helpful for further steps to capture this information. One mechanism would be to create a list under each category and briefly address:

- Description or definition of category
- Possible outcome (desired results)
- Possible objectives (goals)
- Possible outputs (things to do to achieve results)
- Possible indicators of success
- Possible stakeholders
- Possible decision makers
- Key issues to consider

You will also be clarifying what you are beginning to agree upon with this type of exercise. It is better to find differences now than 3 years into a project.

Water Use own inventory/category—make them up, go interview, watch and assess for water bodies of interest

**Stressor Identification role in various monitoring and assessment activities or management programs, from the EPA’s Stressor Guidance Document.**

Table ES.1. Summary of the use of Stressor Identification (SI) in water quality management programs.

| Water Program                          | Type of Program |            |             | Level of Rigor Needed for SI |        |      |           |
|--|-----------------|------------|-------------|------------------------------|--------|------|-----------|
|  | Advisory        | Regulatory | Enforcement | Low                          | Medium | High | ID Source |
| 305(b) Water Quality Reports           | ✓               |            |             | ✓                            | ✓      |      | ✓         |
| 303(d) Impaired Waterbody Lists        |                 | ✓          |             |                              |        | ✓    | ✓         |
| 319 Non-point Source Control           | ✓               |            |             | ✓                            | ✓      |      | ✓         |
| 402 Point Source Permitting            |                 | ✓          | ✓           |                              |        | ✓    | ✓         |
| 316(b) Cooling Water Intake Permitting |                 | ✓          | ✓           |                              | ✓      |      | ✓         |
| 401 Water Quality Certifications       |                 | ✓          |             |                              | ✓      |      |           |
| 404 Wetlands Permitting                |                 | ✓          | ✓           |                              | ✓      |      | ✓         |
| Water Enforcement                      |                 |            | ✓           |                              |        | ✓    | ✓         |

**1.5 Use of the SI Process in Water Quality Management Programs**

Identifying the cause of biological impairments is an essential element of many water quality management programs. Table 1-1 summarizes the stressor identification needs of several water management programs. An extended discussion of some major regulatory programs and their requirements is presented in Appendix A.

**Table 1-1.** The role of SI in various water management programs.

| Program Type/Name   | Purpose   | Role of SI   |
|---|---|--|
| 305(b)<br>Characterizing the Quality of the Nation's Waters   | Under section 305(b) of the Clean Water Act (CWA), states and tribes are required to assess the general status of their waterbodies and identify, in general terms, known or suspected causes of water quality impairments, including biological impairments.   | Stressor identification procedures will assist states and tribes to accurately identify the causes of biological impairment. This is a non-regulatory, information reporting effort. A high degree of certainty in identifying the causes of impairment is not always needed for 305(b) reports.                   |
| 303(d) Listings and TMDLs<br>Identifying Waterbodies and Wetlands that Exceed Water Quality Standards | Under section 303(d) of the CWA, states and tribes are required to prepare and submit to EPA lists of specific waterbodies that currently violate, or have the potential to violate water quality standards, including designated uses and numeric or narrative criteria such as biocriteria. Wetlands assessment programs are also being developed and wetlands may be listed on 303(d) lists. | Accurate, reliable stressor identification procedures are necessary for EPA and the states/tribes to accurately identify the cause(s) of water quality standards violations. A high degree of accuracy and reliability in the stressor identification process is necessary and sources will need to be identified. |
| State/Local Watershed Management Programs   | Managing water resources on a watershed basis involves examining the quality of a waterbody relative to all the stressors within its watershed. Stressors, once identified, are prioritized and controlled through a combination of voluntary and mandatory programs, possibly employing the CWA 402, 319, 404, 401, and other programs.  | Stressor identification procedures will help to identify the different types of stressors within a watershed that may be contributing to biological impairment. A high degree of certainty in identifying the causes of impairment is needed.  |

Table 1-1 (continued). The role of SI in various water management programs.

| Program Type/Name                    | Purpose  | Role of SI   |
|--------------------------------------|--|--|
| 319 Non-point Source Control Program | The 319 Program is a voluntary, advisory program under which the states develop plans for controlling the impacts of non-point source runoff using guidance and information about different types of non-point source pollution.   | Stressor identification procedures will help to identify the different types of non-point sources within a watershed that may be contributing to biological impairment. A high degree of certainty in identifying the causes of impairment is not always needed.   |
| NPDES Permit Program                 | Under Section 402 of the CWA, it is illegal to discharge pollutants to waters of the United States from any "point source" (a discrete conveyance) unless authorized by a National Pollutant Discharge Elimination System permit issued by either the states or EPA. NPDES permits are required whenever a discharge is found to be causing a violation of water quality, including biological impairment. | Accurate stressor identification can be very critical in NPDES permitting cases, both for fairness and success in stressor control. The SI process can help to determine if the discharge is the cause of biological impairment. This is especially important when site-specific modifications of state standards or national criteria are used. A high degree of accuracy and reliability in the stressor identification process is necessary and sources will need to be identified. The SI process is not designed to allocate the amount of responsibility for an impact when multiple sources for a stressor are present. |
| 316(b) Cooling Water Intake Program  | Under Section 316(b) of the CWA, any NPDES permitted discharger which also intakes cooling water must not cause an adverse environmental impact to the waterbody.  | To determine if a cooling water intake structure is causing adverse environmental impacts to the waterbody, the overall health of the waterbody should be known. Where biological impairments are found, stressor identification procedures should be used to identify the different stressors causing the waterbody to be impaired, including the intake structure. A high degree of certainty is needed.   |
| 401 Water Quality Certifications     | Under Section 401 of the CWA, different types of federal permitting activities (such as wetlands dredge and fill permitting) require a certification that there will be no adverse impact on water quality as a result of the activity. This certification process is the 401 Water Quality Certification.   | Stressor identification procedures will help to identify the different types of stress an activity may place on water quality that can then be addressed through conditions in the 401 Certification.  |

Table 1-1 (continued). The role of SI in various water management programs.

| Program Type/Name          | Purpose  | Role of SI  |
|----------------------------|--|---|
| Wetlands Permitting        | Under Section 404 of the CWA, the discharge of dredge and fill materials into a wetland is illegal unless authorized by a 404 Permit. The 404 Permit must receive a 401 Water Quality Certification.                                   | Stressor identification procedures may help to identify unanticipated stress from a dredge and fill activity on water quality or the biological community after the activity is underway. Stressor identification procedures will also help in pre-permitting evaluations of the potential impacts of 404 permitting by assessing different potential stressors on the wetland in advance.  |
| Compliance and Enforcement | Whenever an enforcement action is taken by a regulatory authority, the type of pollution, the source, and other stressors that play a role in causing the violation need to be clearly identified and related to the violating source. | Stressor identification procedures must be able to clearly identify the different types of pollution causing the violation with a high degree of confidence. Legal defensibility is required. Identifying the source with a high degree of confidence is also needed, though the current SI process does not provide that guidance.   |
| Risk Assessments           | Results of bioassessment studies can be used in watershed ecological risk assessments to predict risk from specific stressors and anticipate the success of management actions.  | Accurate stressor identification is an integral part of this process and can help ensure that management actions are properly targeted and efficient in producing the desired results.  |
| Wetlands Assessments       | States are beginning to develop wetlands assessment procedures. In the future, wetlands protection is expected to be increasingly incorporated into state water quality standards.   | Stressor identification procedures, as well as future tools specific to wetland investigations, are very much needed by wetlands managers. The biological assessment methods will allow resource managers to evaluate the condition of wetlands and may provide some indication of the type of stressor damaging a wetland. Once bioassessment methods are completed and incorporated into monitoring programs, wetlands may be listed on 305(b) lists as impaired due to biological impairment. The SI process should help identify stressors causing biological impairment so resource managers can better remedy the problems. |

Table 1-1 (continued). The role of SI in various water management programs.

| Program Type/Name               | Purpose   | Role of SI  |
|---------------------------------|---|---|
| Preservation Programs           | The National Estuary Program (NEP) was established in 1987 by amendments to the Clean Water Act to identify, restore, and protect nationally significant estuaries of the United States. The program focuses on improving water quality in an estuary, and on maintaining the integrity of the whole system --its chemical, physical, and biological properties--as well as its economic, recreational, and aesthetic values. | Stressor identification procedures should be useful to the NEP, and other preservation programs, by helping stakeholders identify causes of impairments. This information would feed into the development of a management plan.   |
| Restoration Programs            | The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, was enacted in 1980 (and amended in 1986) for hazardous waste cleanup.   | As in enforcement and compliance programs, stressor identification procedures must be able to clearly identify the different types of pollution causing the impairment with a high degree of confidence. Legal defensibility is required. Identifying the source with a high degree of confidence is also needed, though the current SI process does not provide that guidance. |
| Pollution Control Effectiveness | A key component of any pollution control program or watershed management effort is the ability to ascertain (or predict) the likely effectiveness of pollution control measures or management strategies.   | Stressor identification procedures will help to identify the different types of pollution a control measure needs to reduce and the different types of stressors a management strategy needs to address.  |

## Uses, values, Threats workshop

### Uses, Values and Threats Workshops (include status or condition)

Public workshops are a great way to involve watershed residents in your program, to learn about how your stream or lake is being used, what people think is important and problem areas. They are also a good way to build a list of potential monitoring volunteers. After all, they came to your workshop; they must be interested in the water! Give members of your watershed communities an opportunity to help you identify water-related uses, special attributes and problems by holding one or more *Uses, Values and Threats Workshops*. At these workshops, explain your program ideas and assemble the topographic maps, or some other clear base maps, that cover your watershed. Invite participants to identify and locate water use areas, special attributes and problem areas using labeled or color-coded “post-it” notes. You can learn a surprising amount about your water body through this exercise.

### Threats and Issues Identification

**What are the most pressing threats and issues facing your waters?** What are the key areas to preserve, reclaim, focus on, etc.? What might the important ecological, political, social, economic functions that you are trying to preserve, may need to utilize, change or focus on in some manner? What are sensitive or endangered habitats? What might benchmarks be for the watershed vision (ecological, political, social and economic)?

You can look at threats and issues from possible goals:

### Water Quality

- Identify and Reduce pollutants of concern
- Meet water quality standards
- Allow water contact recreation
- Prevent illegal discharges or spills
- Reduce sediment contamination
- Protect drinking water supply

### Biological

- Restore aquatic diversity
- Expand forest cover
- Improve fish passage
- Remove invasive species
- Enhance riparian area and or function
- Restore wetlands/natural areas
- Restore/reintroduce species
- Enhance wildlife habitat
- Keep shellfish beds open

### Physical/Hydrological

- Increase groundwater recharge
- Reclaim stream network
- Reconnect floodplain
- Protect municipal infrastructure
- Reduce channel erosion
- Reduce flood damage
- Restore physical habitat

## Community

- Eliminate trash/debris
- Revitalize neighborhoods
- Increase citizen awareness
- Increase angling opportunities
- Create greenways/waterfront access/open space
- Improve aesthetics/beautifications
- Improve recreation opportunities
- Change perception of waterbody condition/health

## Perception Survey or Values Survey/mapping

Both of these are community, public type surveys. In a perception survey your goal is to be able to identify, define and or quantify the public's perception of a certain waterbody. What is the public's perception of quality, use, condition, health, etc? Why you want this? Perhaps there was a historic toxic waste or spill from some event or plant that is no longer physically there, but the legend of water being "so bad that..." still lingers. The economic development board is working on a plan to increase recreation, bike path, etc. and view the public's perception an obstacle.

The key is to clarify what perceptions you are trying to assess and why. Identify who you need to understand and be creative in ways to reach them.

A value survey is one that attempts to identify the values of a targeted public, user group, stakeholder, community, or the like. You need to play with language to make sure your biases and definitions are clear and you are getting the answers you desire from well thought out questions. It is common and valuable to pilot your surveys and have folks tell you what they think you are asking and tweak accordingly. The purpose for conducting and value's survey ranges, but it may be important and significant for the success of your work to align organizational values and project goals with community values. It may provide you with a gage on how much support or lack of support there is, which may help you leverage resources or tell you might need to conduct more education effort. The key is to clarify what perceptions you are trying to assess and why. Identify who you need to understand and be creative in ways to reach them.

Usually, the results from a survey are used to determine what type of monitoring or education may be needed and what and who to focus these efforts on. Implementation of these surveys vary, from mailings only, mailings with phone interviews, phone interviews, presentation/survey delivery to specific groups, handed out after and event or experience, combinations or other mechanisms. There is no one manner. Another concept that can be employed to understand what is important to people in the watershed is a take off of the Green Mapping System. In the traditional Green Mapping System, invites students and volunteers to create their own green maps charting the ecologically significant places, projects and organizations in their home communities. The concept was developed to promote urban environmental health and awareness. The maps are as informal as hand drawn on newsprint or brochures available and chamber of commerce's. You can create specific definitions, categories and symbols or have it be more free form. Green mapping items for the project included categories such as:

- ✓ Gardens, parks, zoos, places of natural beauty, wildlife habitats, etc.
- ✓ Farmer's markets, eco-businesses, sustainable farms and developments,
- ✓ Pedestrian zones, bike lanes, mass transit, car-free zones
- ✓ Cultural resources, historical features, eco-tourism destinations
- ✓ Solar and other renewable technology sites
- ✓ Important social, governmental and health information resources

- ✓ Bioregional, geological and other natural features,
- ✓ Water, power and waste infrastructures
- ✓ Environmentally sound architecture and projects
- ✓ Toxic hot spots and pollution sources

The adaptation would be to conduct community gatherings or stakeholder meetings, provide the criteria and let folks draw their watershed map. The adaptation in criteria would include anything you want to know from there perspective, perception or value. It could be use related, culture related, impact related or value relation, some examples might include:

- ✓ Special places along the river corridor and why (define special or break out categories for them)
- ✓ Swimming holes
- ✓ Pollution sources/threats to system
- ✓ Toxic hot spots
- ✓ Public access
- ✓ Fishing or duck hunting
- ✓ Desired access

Green mapping or an adaptation can help to discover new resources for preserving and sustaining, places to focus education and or monitoring activities or places with common uses, values or perceptions.

### **Green Mapping System**

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- ✓ Pedestrian zones, bike lanes, mass transit, car-free zones
- ✓ Cultural resources, historical features, eco-tourism destinations
- ✓ Solar and other renewable technology sites
- ✓ Important social, governmental and health information resources
- ✓ Bioregional, geological and other natural features,
- ✓ Water, power and waste infrastructures
- ✓ Environmentally sound architecture and projects
- ✓ Toxic hot spots and pollution sources

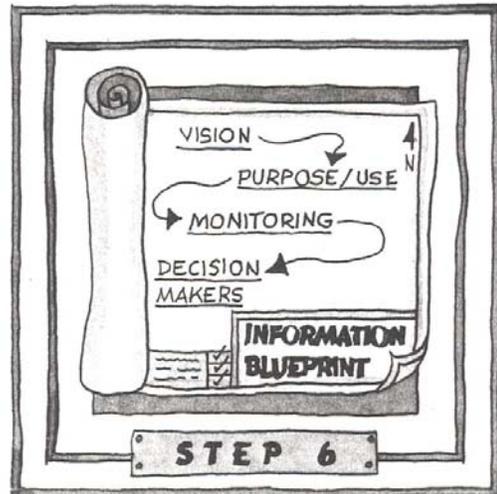
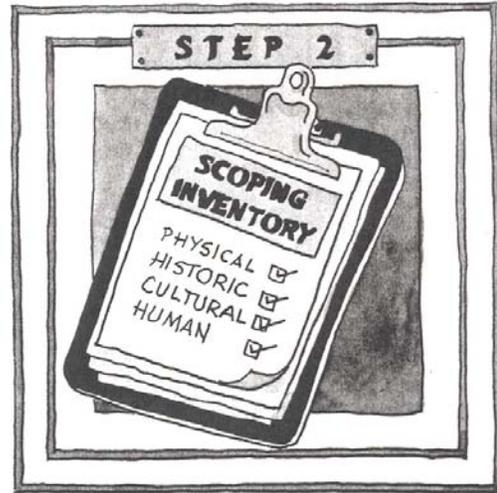
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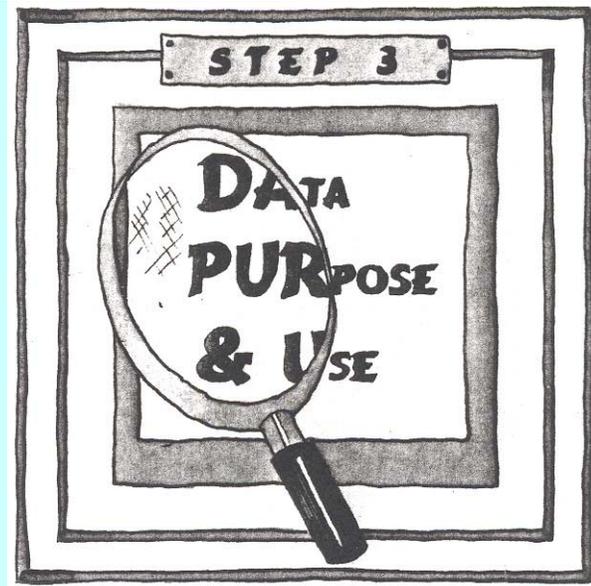
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- ✓ Pollution sources/threats to system
- ✓ Toxic hot spots
- ✓ Public access
- ✓ Fishing or duck hunting
- ✓ Desired access

Green mapping or an adaptation can help to discover new resources for preserving and sustaining, places to focus education and or monitoring activities or places with common uses, values or perceptions.

# PHASE I PEOPLE DESIGN



## Step 3: Identify Monitoring Reason(s) and Data Use(s) = Assessment Type



“If consumer society has one Achilles’ heel, it is not that it is going to destroy the earth—it is, but that is not the Achilles’ heel. The Achilles’ heel is that consumer society doesn’t make us unbelievably happy.”

**Bill McKibben**

**About This Step** - *This step is designed to accomplish 3 things:*

1. Transformation Activity. Transform the products from Step 1 (vision, outcomes, outputs related to monitoring and assessment, possible decision makers with the products from Step 2 (physical inventory, watershed delineation, water bodies of interest, etc. people and information inventory) into meaningful and focused information. Result is to identify appropriate assessment types and corresponding data pathways.
2. Introduce and select Assessment Types. Assessment types are combinations of a specific *monitoring reason + data use(r)*. Assessment types are provided so we can have a common language for what we are doing across watershed assessments and decision makers.
3. Provide an organizational **relevance check** once Assessment Type(s) are selected and data pathways are identified against organizational values and resources. Re-evaluate choices based upon vision, outcomes, outputs, physical and people inventory and identified gaps. If necessary re-select assessment type.

## Why Do This Step?

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We need to keep focusing at the same time stay connected to our watershed vision and desired outcomes. This step is one way to categorize, focus and translate our monitoring and assessment activities into a common language.

In Step 1 we used the Logic Model to illustrate and communicate how we plan to achieve a defined watershed vision. We identified outcomes or results that would indicate the watershed is moving toward the vision. We then identified activities and target audiences that would achieve those results or outcomes. From this list we identified outputs that were associated with monitoring or assessment. We then listed a general list of potential decision makers and decisions they make for each monitoring and assessment activity. In Step 2 we evaluated what type of information we needed our monitoring and assessment activities to generate, what information existed in the watershed, what we needed and who might have it or be gathering it.

How does this step focus and translate? Any monitoring and assessment efforts should have identified monitoring reasons and data uses (users). The common combination of a monitoring reasons and data uses can be lumped into general Assessment Types. Identifying monitoring reason and uses is an essential ingredient for designing a monitoring program that will generate meaningful data that can be transformed into information, delivered to a decision maker and evaluated.

This is monitoring and assessment 101, lesson 1. If we don't know the purpose for the data being generated, how can we insure we are collecting the right information and if the purpose was achieved? If we don't know what the intended data uses are, associated users and their information needs, how can we know if what we are collecting and generating will meet those needs, those uses? If a monitoring reason and or a data use is not identified how do you know what information is being generated for whom and if it was successful or not? These two elements are not to be assumed, but consciously identified and documented.

After monitoring reasons and uses are identified we must design the data pathway. The planned path each data point generated will travel to become information, be delivered to a decision maker and then be evaluated for effectiveness. The selected monitoring reason and data use (users) play a significant role in defining a successful data pathway that actually has a defined endpoint. Data does end up being "used" for a "purpose" without a plan, often it is not used at all. This makes effectiveness evaluation easy, evaluation equals "data goes where it goes, if it goes, I will follow it there and see what happens and decide if it was effective or not."

In fact, data is often used for purposes it was not intended. All of these are reasons to document why you are doing what you are doing. This assists others in making accurate decisions with your data and also prevents misuse of your data and provides more opportunities for use of your data.

In essence this step merges your watershed vision, outcomes, monitoring and assessment activities and scoping inventory into a monitoring reason with identified data users. The result is a list of Assessment Types you could conduct (or perhaps are). Thus, now is another valuable time to conduct an organization relevance check. Do the prioritized assessment types align with organizational

values, watershed vision, outcomes, and project objectives? How do they relate to the Inventory Action Plan needs and gaps? Re-adjust, re-prioritize before resources are expended.

If one of the Assessment Types in this Step does not fit your monitoring reason and use, identify your own. The remainder of this Phase and Phase 2, 3 and 4 all use the common language that an Assessment Type provides to finish this plan.

Phase 1 Step 4 will refine monitoring reasons further by identifying monitoring questions. Phase 1 Step 5 refines data uses further by identifying a decision maker for every monitoring question, the decision they will make and their information needs in order to make that decision. This is the framework to illustrate a data pathway for each monitoring question or the details of how the data generated for a specific purpose will get to a targeted decision maker.

## Where are we in the Big Picture Illustration?

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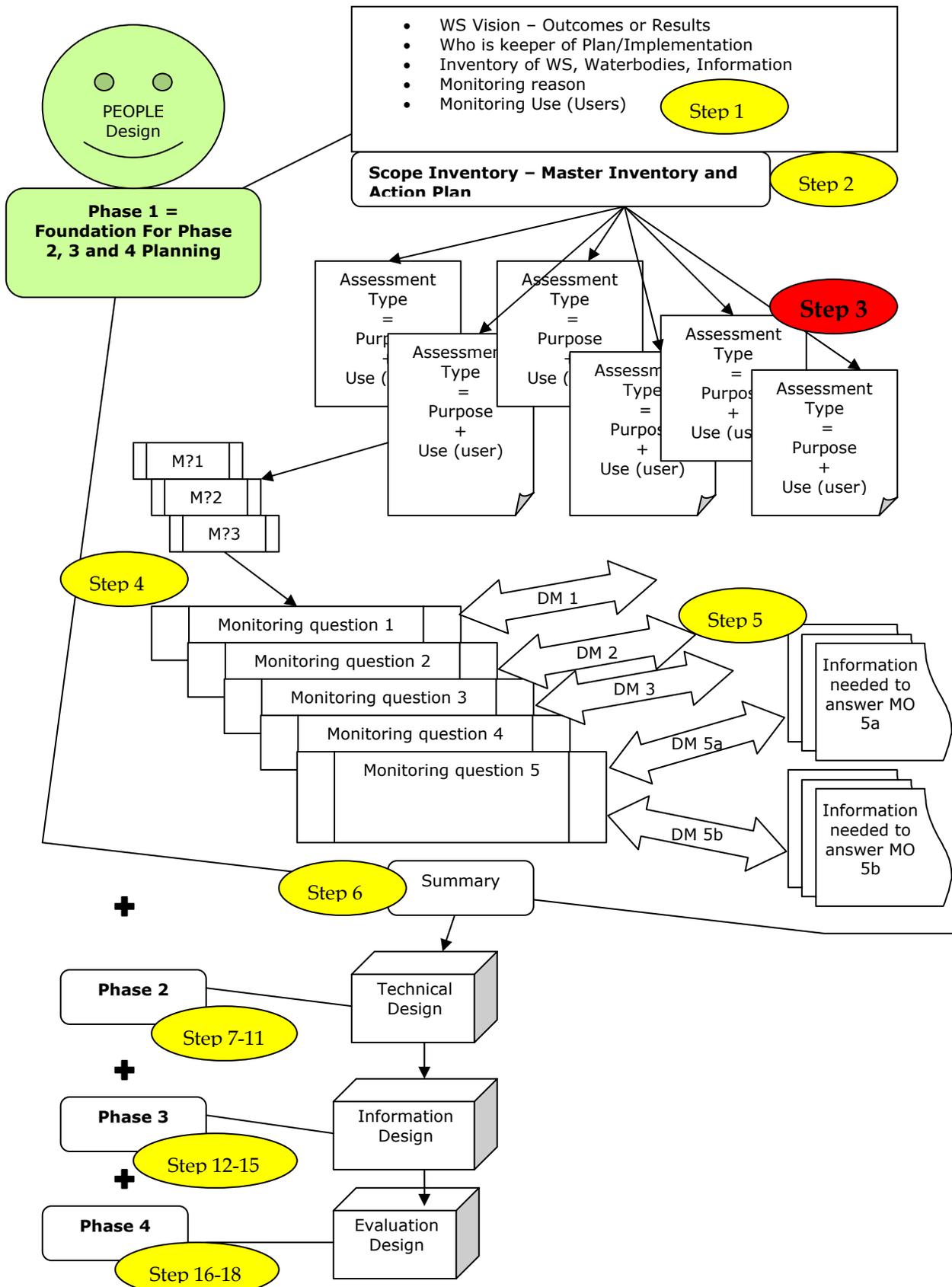
|         |  |
|---------|--|
| Phase 1 | Step 1: Share Watershed Vision and Desired Outcomes (Results)<br>Step 2: Scope Inventory (Physical, People and Information)<br> <b>Step 3: Identify Monitoring Reason(s) and Data Use(s) (Assessment Type)</b><br>Step 4: Develop Monitoring Questions (Refinement of Monitoring Reason)<br>Step 5: Target Decision Makers and Info Needs (Refinement of Data Use)<br>Step 6: Summarize with Information Blue Print-Data Pathway Fact Sheet |
| Phase 2 | Step 7: What Will You Monitor?<br>Step 8: When Will You Monitor?<br>Step 9: Where Will You Monitor?<br>Step 10: How Will You Monitor to Meet Data Quality Objectives?<br>Step 11: Management of Raw Data (Data Management Plan Part 1)   |
| Phase 3 | Step 12: Data Summary and Analysis<br>Step 13: Interpretation, Conclusions and Recommendations<br>Step 14: Communicating and Delivery<br>Step 15: Management to Generate Info (Data Management Plan Part 2)  |
| Phase 4 | Step 16: Who Will Do What? Task Identification<br>Step 17: Evaluation of Effectiveness (of Plan and Implementation)<br>Step 18: Documentation and Communication (of M & A Plan)  |

## Product (see Figure Phase1 Product List):

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- ✓ Selected Assessment Types or specific combinations of one monitoring reason and one data use. This is a synthesis of Step 1 and Step 2 products into identified combinations of monitoring reasons and data uses. Each combination equates to one Assessment Type, used for communication and planning for Technical Design (Phase 2), Information Design (Phase 3) and Evaluation Design (Phase 4).
- ✓ Prioritization of Assessment Types Listed because conducted an organizational relevance check of choices against resources.

Phase 1 Product Illustration:



## What Should Be Done Before This Step

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In Step 1 we used the Logic Model to illustrate and communicate how we plan to achieve a defined watershed vision. We identified outcomes or results that would indicate the watershed is moving toward the vision. We then identified activities and target audiences that would achieve those results or outcomes. From this list we identified outputs that were associated with monitoring or assessment. We then listed a general list of potential decision makers and decisions they make for each monitoring and assessment activity. In Step 2 we first identified our general information needs and then our watershed and water bodies focus. Next we evaluated what information existed in the watershed, what we needed and who might have it or be gathering it. This step synthesizes this information into combinations of monitoring reasons and data uses.

If you did not complete Phase 1, Steps 1 and 2, at a minimum you need to have identified the basic monitoring and assessment activities you are doing or are interested in. You need to know the watershed boundary and water bodies of interest and the overall outcomes the monitoring and assessment activities are supposed to support.

## Basic Tasks

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Basic Tasks are numbered to correlate with the overall 1-18 Steps provided in these guidance modules followed by the basic task sequence step to complete. For example Step 4, basic task 2 would be numbered as Basic Task Step 4.2, Step 3.3 correlates to Step 3, Basic Task 3.



3.1 Identify who will make the decisions about this step and who should be involved in the planning process (they may be different).



3.2 Self Assessment: Identify what decisions have been made and their effectiveness.



3.3 Identify Specific Monitoring reasons, for each reason the Data Uses.



3.4 Identify all appropriate Assessment Types or combinations of monitoring reasons and data uses.



3.5 Conduct an organizational relevance check. With your selected assessment types and associated monitoring reason(s) and data use(s).



3.6 Update *Inventory Master List* and *Plan*.



3.7 Place Products in your *Watershed Monitoring and Assessment Plan*.



3.8 Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan).

## Worksheets

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Worksheets are listed below. Not all Basic Tasks have an associated work sheet. To simplify completion of products for each step, the worksheets or broken into small subsets of tasks. This requires moving the results of one task into the next task and will seem redundant, especially if completing worksheets by hand. Worksheets are provided in word here for ease of reproducibility. These are a starting point; we encourage you to customize these and reproduced them in an electronic format, in Excel for example, where it is easy to move information from one area to another by cutting and pasting.

Worksheets are numbered to correlate with Basic Steps and the overall Steps in these guidance modules. Each consecutive work sheet is lettered a, b, c and so forth, preceded by the Basic Task sequence step, preceded by the Step number. For example, Worksheet Step 4.2.a and Step 4.2.b, correlates to Step 4, Basic Task 2, Worksheet a and Worksheet b. In theory worksheet a needs to be completed before worksheet b.

- Worksheet 3.2.a**      **Self Assessment Step 3 Worksheet and Products to be completed Prior to this Step, Part 1 and 2**
- Worksheet 3.3.a**      **Potential Monitoring Reasons and Data Uses**
- Worksheet 3.4.a**      **Identify all appropriate Assessment Types or relevant combinations of monitoring reasons and data uses**
- Worksheet 3.7.a**      **Place Products in your *Watershed Monitoring and Assessment Plan***
- Worksheet 3.8.a**      **Final *Action Plan* Part 1, Summary:**

## How to do Worksheets

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**For Sheet 3.2.a      Self Assessment: Identify what decisions have been made and their effectiveness.**

Part 1. Complete the self assessment section of the worksheet to evaluate what you have or what decisions have already been made. This will help you focus on what you need from this step and incorporate valuable existing information or products into this plan.

Part 2. Next, to prepare to complete this step the following, you need to have the following items addressed:

- √ Desired set of outcomes or results that the monitoring and assessment activities will be designed to help achieve
- √ Generally identified monitoring and assessment activities,
- √ A minimal scoping inventory that identifies the watershed boundary and water bodies you are focusing on (rivers, lakes or wetlands), physical attributes of water bodies (including status, uses, etc.), relevant cultural or historical aspects, existing data sets or monitoring efforts and others in the watershed who either you want to influence or could help you implement.

This is the ideal list, if you do not have any of these, they become a gap or need that should be addressed before any data is collected or analyzed, even if the answers aren't perfect or you don't have a large degree of confidence surrounding them, they should be attempted as the starting point. This is what you are evaluating in this step-your monitoring and assessment plan.

**Worksheet 3.2.a Self Assessment Step 3 Worksheet and Products to be completed Prior to this Step, Part1.**

*Part 1 Self Assessment of Known Evaluation Products and Processes*

- 1. Determine if you “have” or “don’t have” the item, mark the appropriate box. If you don’t have it and determine you don’t need it, explain why in the comments document. You may not need to know but perhaps your target decision makers, board or membership might want to know.**
- 2. If you have the item “documented”, mark that box. If so, list in the comments where, hard copy, chapter in a document, electronic file name and location, etc. The assumption is you value the ultimate goal to document and communicate your M & A plan, activities and results.**
- 3. If you have the item, assess the use of it, use the scale below or provide your own answer and comments.**

Rating Scale for USE:

- 0=doesn’t exist so use is nil
- 1=don’t know why would need or understand item
- 2=exists, don’t know where it is, if it is used, etc. so use is essentially nil
- 3=exists and use some of time
- 4=exists and use all the time
- 5=wish it existed, would use it lots

- 4. If you have the item, assess the effectiveness of it, just because something exists or is used does not mean it is effective in its use, use the effectiveness scale below or provide your own answer and comments.**

Rating Scale for EFFECTIVENESS, assumes material exists:

- 0=not effective or functional at all
- 1=incomplete (all elements are not there) and some existing parts need revising
- 2=incomplete but what is there is okay
- 3=complete (all elements are there), some parts okay but need revising
- 4=complete and effective

| Item  | Have | Don't Have | DOC | Assessment of Use (Scale 0-5) | Assessment of Value / Effectiveness (Scale 0-4) | Comments |
|---|------|------------|-----|-------------------------------|---|----------|
| 16. Assessment Types, combinations of monitoring reasons and data uses to meet outcomes |      |            |     |                               |   |          |
| Other?  |      |            |     |                               |   |          |

\*DOC=Documentation, \*M & A= Monitoring and Assessment

- 5. To make this assessment useful, determine what your gaps and needs are regarding this step in order to focus your effort in completing this step.**

**Worksheet 3.2.a Self Assessment Step 3 Worksheet and Products to be completed Prior to this Step, Part 2.**

*Part 2 Products to be completed before this step, in order to complete this step*

| Item   | Response |
|--|----------|
| Desired set of outcomes or results that the monitoring and assessment activities will be designed to help achieve: |          |
| General idea of monitoring reason and data use(r) to achieve desired outcomes:                                     |          |
| Watershed(s) and Water bodies of focus:  |          |
| Physical attributes of Water bodies (status, use, etc.)  |          |
| Existing Data or monitoring efforts:   |          |

**For Sheet 3.3.a Identify Specific Monitoring reasons, for each reason the Data Uses.**

You have a watershed vision, identified outcomes or results that would indicate the vision is manifesting. You generated a list of general or specific (existing or planned) monitoring and assessment activities with targeted decision makers associated to help achieve one or more of the outcomes in the Logic Model (Results of Step 1), Worksheet 1.9.a, you generated a list of information needed from your monitoring and assessment activities in Step 2, Worksheet 2.3.a, as well.

You also have a delineated watershed boundary, a list of target water bodies, information about the watershed and water bodies, and information about who is doing what in the basin (as well as other physical and people inventory data)(Result of Step 2). This is the starting point.

*Step 1. For each monitoring and assessment activities identified in Step 1, or right now, define the associated monitoring reason. If you need a list to choose from see below:*

- A. **Purpose:** To *characterize* water quality in general (conditions and trends) for the purposes of identifying long-term trends and/or areas of impact;
- B. **Purpose:** To *assess the impact* of threats in order to design strategies to reduce or control those threats;
- C. **Purpose:** To *evaluate the effectiveness* of pollution reduction, control and/or management strategies;
- D. **Purpose:** To *assess the viability* of a particular use or uses, related violations of water quality standards, and appropriateness of the river segment for the States list of “threatened waters” (303d List).

If your purpose is not listed above, make your own category.

*Step 2. Once you have identified each monitoring reason, for each of those, list one data use/user. If you need a list of ideas see below:*

- Education target?
- Advocacy target?
- Local decision and policy makers
- Agency partners
- Industrial water users
- Recreational water users
- Recreational businesses
- Retailers of water recreation equipment
- Agricultural commodity groups
- Landowners
- Households
- Homeowners, associations
- Neighborhood associations
- Service clubs
- Environmental / Conservation organizations

- Non governmental organizations
- Soil or water conservation districts
- Watershed associations or groups
- Professional Organizations (construction, etc.)
- Specific socio-economic, age, gender, etc.

*Step 3. Organize by all common monitoring reasons and varying data uses or visa versa, all common data uses and varying monitoring reasons, or both. You will use this list in the next Basic Task and Worksheet. Don't worry about the Assessment Type column.*

**Worksheet 3.3.a Potential Monitoring Reasons and Data Uses**

*From the Logic Model results in Step 1, Worksheet 1.9.a, or from other resources, list one monitoring reason per line. Once complete, for each monitoring reason, list the intended data use. If you have more than one data use per monitoring reason, list the reason again with the second use. Don't worry about the Assessment Type yet, that is the next step. Edit or modify to fit your needs. If you complete on the computer you can put all the same monitoring reasons with different data uses together. If it is useful and you need to this view, you can organize the list by the same data use and their multiple monitoring reasons (re-ordered).*

| Monitoring Reason | Associated Data Use | Assessment Type |
|-------------------|---------------------|-----------------|
|                   |                     |                 |
|                   |                     |                 |
|                   |                     |                 |
|                   |                     |                 |
|                   |                     |                 |
|                   |                     |                 |
|                   |                     |                 |

**For Sheet 3.4.a Identify all appropriate Assessment Types or combinations of monitoring reasons and data uses.**

Using your reorganized Worksheet 3.3.a, list of monitoring reason and associated data use and the provided Assessment Type Matrix, identify for every combination of monitoring reason and data use an Assessment Type. Provide comments if need be.

You can have multiple AII for example, if you have the same reason and two different data users. For example my monitoring reason is trend assessment, but I have one audience, the state health department and another audience our local Trout Unlimited Chapter. These groups have different information needs, decision processes and action possibilities. The state will use our data to determine long term changes in trend and attainment or impairment. The Trout Unlimited Chapter will be using the data to determine the success of native trout introductions over time. Thus, I really will be conducting two AII Assessments Types, one purpose, two different uses. You can distinguish between them by nomenclature, AII-a and AII-b for workbook purposes.

Conversely you could have one data use that has multiple monitoring reasons each with their own single monitoring reason category. For example, we might collect data for the state health department to determine the effectiveness of two different mining BMP's and restoration projects. Two completely different information needs and thus study designs perhaps and even areas within the watershed. I would be conducting two CII Assessment Types.

Conduct several iterations of this exercise in as specific detail as possible. The results become the basis for your monitoring and assessment design. When complete, prioritize the assessment types if you have more than one, provide the rationale in writing for others not part of the decision but part of the implementation to understand.

| Study Purpose(s)                            |                  | Data Use(s)   |   |   |
|---|------------------|---|---|---|
|   |                  | <b>I<br/>Education/<br/>Community Inquiry</b>   | <b>II<br/>Community or Agency<br/>Advocacy/<br/>Planning</b>                        | <b>III<br/>Regulatory/<br/>Legal</b>      |
| <b>A. Condition and Trend Investigation</b> |                  | <b>Assessment A-I</b><br>General background information                                     | <b>Assessment A-II</b><br>Watershed Management Planning; 305(b) report              | N/A1                                      |
| <b>B. Impact Investigation</b>              | Non Point Source | <b>Assessment B-I</b><br>Educate community or students about pollution impacts              | <b>Assessment B-II</b><br>Identify impacts for remediation                          | <b>Assessment B-III</b><br>CWA Violations |
|   | Point Source     | <b>Assessment B-IV</b><br>Educate community or students about pollution impacts             | <b>Assessment B-V</b><br>Identify impacts for remediation                           | <b>Assessment B-VI</b><br>CWA Violations  |
| <b>C. Effectiveness Investigation</b>       |                  | <b>Assessment C-I</b><br>Educate students about effectiveness of BMPs, restoration projects | <b>Assessment C-II</b><br>Evaluation of effectiveness of BMPs, restoration projects |   |
| <b>D. Use Support Investigation</b>         |                  | <b>Assessment D-I</b><br>Community or student education about use impacts                   | <b>Assessment D-II</b><br>Watershed Management Planning; 303(d) report              | <b>Assessment D-III</b><br>CWA violations |

<sup>1</sup>N/A here is because the audience for trend and condition information is not usually regulatory or legal, regulatory or legal entities may indeed use trend and baseline information but not as the regulatory or legal endpoint-usually trend/baseline information lead to specific regulatory/legal endpoints. If this is not true for you A-III is your assessment type, there are no examples further in this text for A-III.

**Worksheet 3.4.a Identify all appropriate Assessment Types or relevant combinations of monitoring reasons and data uses.**

*Use Worksheet 3.3.a, cut/paste or start from here, which ever is easier. Assign each combination of monitoring reason and data use an Assessment Type.*

| Monitoring Reason | Associated Data Use | Assessment Type | Comments |
|-------------------|---------------------|-----------------|----------|
|                   |                     |                 |          |
|                   |                     |                 |          |
|                   |                     |                 |          |
|                   |                     |                 |          |
|                   |                     |                 |          |
|                   |                     |                 |          |
|                   |                     |                 |          |
|                   |                     |                 |          |

**For Sheet 3.7.a** Place Products in your *Watershed Monitoring and Assessment Plan*.

➡ Assessment Types committed to, specific combinations of monitoring reason and data use(s)

**Worksheet 3.7.a** Place Products in your *Watershed Monitoring and Assessment Plan*.

I. People Design, Phase 1

A. Shared Watershed Vision and Desired Outcomes (Step 1)

1. Logic Model of Desired Outcomes/Results and activities/target audiences to employ to achieve outcomes

B. Keepers of the M & A Plan (Step 1)

C. Watershed Boundary (Step 2)

D. Water bodies of Interest (Step 2)

E. Scope Inventory Master List\* (Step 2)

1. Physical Inventory \* (Step 2)
2. People Inventory\* (Step 2)
3. Information Inventory\* (Step 2)
  - a. Existing Monitoring Efforts (Step 2)
  - b. Existing Data Sources (Step 2)
4. Inventory Action Plan\* (Step 2)

F. ➡ Assessment Type(s) List – Monitoring Reason + Use (Step 3)

1. Monitoring Question(s) (Step 4)
2. Targeted Decision Maker(s) (Step 5)
  - a. Information Needs (Step 5)
3. Information Blue Print – Data Pathway Fact Sheet Per Monitoring Question\* (Step 6)

II. Technical Design, Phase 2

A. What (Indicators, Benchmarks, etc.) and why? (Step 7)

B. When and why? (Step 8)

C. Where and why? (Step 9)

D. W(how) will meet data quality objectives? (Step 10)

1. Data quality objectives (Step 5 and 10)

2. Quality Assurance and Control Measures (Quality Assurance and Control Plan)\* (Step 10)

- E. Data Management for Raw Data (Data Management Plan Part 1)\* (Step 11)

### III. Information Design, Phase 3

- A. Data Summary and Analyses (Step 12)

1. Starting Point (Step 12)
2. Changes (Later)

- B. Data Interpretation, Conclusions, Recommendations

1. Starting Point (Step 13)
2. Changes (Later)

- C. Communication and Delivery

1. Starting Point (Step 14)
2. Changes (Later)

- D. Management Plans to Generate Information (Data Management Plan Part 2)\* (Step 15)

### IV. Evaluation Design, Phase 4

- A. Who Will Do What? (Step 16)

1. Task Identification Matrix (Step 16)
2. Communication Structure and Tools (Step 16)

- B. Evaluation Plans (Step 17)

1. Evaluation Plans for M & A Components (Step 17)
2. Evaluation Plans for M & A Implementation (Step 17)
3. Evaluation of inter/intra M & A Activities (Step 17)

- C. Documentation and Communication (Step 18)

1. M & A Plan (**this document**, updated Sub documents) (Step 18)
2. Communication and Peer Review Plan (Step 18)
3. Action Plan\* (Step 17)

**For Sheet 3.8.a**      **Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan).**

**Worksheet 3.8.a**      **Final *Action Plan* Part 1, Summary:**

*If you have completed each Step, or for those you have, you have a cumulated list of gaps and needs related to that Step. Use that same worksheet/document. If you did not complete each Step, look at what each Step is supposed to accomplish and record what your gaps and needs are related to that topic. The goals are to get the gaps and needs in one place to evaluate and prioritize.*

|  |
|--|
| <b>Phase 1 Step 1: (completed in Step 1)</b>   |
| <b>Phase 1 Step 2: (completed in Step 2)</b>   |
| <b>Phase 1 Step 3:</b>   |
| <b>Phase 2, 3 and 4 Steps: Will add Action and Needs as complete each Step and at the end prioritize</b> |

## Background and Content

### Identify Monitoring Reason(s)

**Assessment Type = Specific Monitoring Reason + Specific Date Use**

In Step 1 we used the Logic Model to illustrate and communicate how we plan to achieve a defined watershed vision. We identified outcomes or results that would indicate the watershed is moving toward the vision. The logic model looks like the figure below.

|                     |                            |               |                         |          |           |
|---------------------|----------------------------|---------------|-------------------------|----------|-----------|
| <b>Situation:</b>   |                            |               |                         |          |           |
| <b>Inputs</b>       | <b>Outputs</b>             |               | <b>Outcomes</b>         |          |           |
|                     | <b>Activities Audience</b> |               |                         |          |           |
| What we Invest      | What We do                 | Who we Target | Short Term              | Mid Term | Long Term |
|                     |                            |               |                         |          |           |
| <b>Assumptions:</b> |                            |               | <b>External Factors</b> |          |           |
|                     |                            |               |                         |          |           |

We then identified activities and target audiences that would achieve those results or outcomes. From this list we identified outputs that were associated with monitoring or assessment. We then listed a general list of potential decision makers and decisions they make for each monitoring and assessment activity. In Step 2 we evaluated what type of information we needed our monitoring and assessment activities to generate, who makes decisions in the watershed, what information existed in the watershed, what we needed and who might have it or be gathering it.

From your general list of monitoring and assessment activities from Step 1, let's use those and refine that general list to specific combinations of one monitoring reason and one data use (user). In the next two Steps we first refine monitoring reason, then data use, then we summarize both. So, first let's get specific monitoring reasons. We suggest that monitoring reasons might fall into the following four areas:

- A. **Purpose:** To *characterize* water quality in general (conditions and trends) for the purposes of identifying long-term trends and/or areas of impact;
  - ◆ **Objective:** Baseline
  - ◆ **Objective:** Status
  - ◆ **Objective:** Trend
  - ◆ **Etc.**

- B. **Purpose:** To *assess the impact* of threats in order to design strategies to reduce or control those threats;
- ◆ **Objective:** Threat or Source Type 1
  - ◆ **Objective:** Threat or Source Type 2
  - ◆ **Etc.**
- C. **Purpose:** To *evaluate the effectiveness* of pollution reduction, control and/or management strategies;
- ◆ **Objective:** Protection/Restoration Strategy Type 1
  - ◆ **Objective:** Protection/Restoration Strategy Type 2
  - ◆ **Etc.**
- D. **Purpose:** To *assess the viability* of a particular use or uses, related violations of water quality standards, and appropriateness of the river segment for the States list of “threatened waters” (303d List).
- ◆ **Objective:** Aquatic Life (by type)
  - ◆ **Objective:** Recreation
  - ◆ **Objective:** Drinking

If your purpose is not listed above, make your own category to add to the Assessment Type Matrix. If you struggle with this, another resource that might provide more content and description is the *California Watershed Assessment Manual Draft*, [http://cwam.ucdavis.edu/Manual\\_chapters.htm](http://cwam.ucdavis.edu/Manual_chapters.htm), Chapter 8, Use of the Watershed Assessment for Decision-making.

### Identify Monitoring Use(s)

Now, from your general list of monitoring and assessment activities and list of potential decision makers from Step 1, let’s focus all possible data uses for all the identified monitoring reasons. We suggest that data uses might fall into the one of the following three areas:

1. **For educational use:** This purpose means that the information collected will be used to increase people’s understanding and appreciation of the way watersheds work. The goal is that they will act on this understanding to minimize their impacts on the integrity of the ecosystem. To inform usually means you are imparting data one way, to communicate you desire a two way dialogue, to educate is a formalized process with a learning objective or goal and capacity building involves processes that increase both knowledge and skill.
2. **For advocacy or planning use:** The data will be used for determining appropriate water body protection and restoration measures at the local, watershed, or state level. These data are not intended to be used for regulatory purposes, but rather plugged into planning and other processes that will lead to widely agreed-upon, and mostly voluntary protection and restoration actions.

3. **For regulatory or legal use:** While we are not advocating that community-based monitoring program collect data to be used for regulatory purposes directly (e.g. to allocate pollution loads under a TMDL, shut down a beach, deny a discharge permit, etc.), we include this as a data use in order to demonstrate the level of rigor required. Some groups may be perfectly capable of producing data of this quality, but don't intend it to be used this way.

If your data use is not listed above, make your own category to add to the Assessment Type Matrix. A general list of possible data uses/users to get the creative juices flowing:

- Local decision and policy makers
- Agency partners
- Industrial water users
- Recreational water users
- Recreational businesses
- Retailers of water recreation equipment
- Agricultural commodity groups
- Landowners
- Households
- Homeowners, associations
- Neighborhood associations
- Service clubs
- Environmental / Conservation organizations
- Non governmental organizations
- Soil or water conservation districts
- Watershed associations or groups
- Professional Organizations (construction, etc.)
- Specific socio-economic, age, gender, etc.

**Identify all appropriate Assessment Types (combinations of monitoring reason(s) and data use(s)) for streams.**

Assessment Types are provided so we can have a common language for what we are doing across watershed assessments and decision makers.

There are 4 basic **Monitoring reasons or Types** of Investigations described in this workbook:

1. **Condition and Trend Investigation:** Condition and Trend Investigation for wade able waters seeks to balance limited time and resources with the goal of sampling as many different aspects of the stream ecosystem as possible in as many different locations throughout the watershed as possible. The focus may be limited to relatively small areas or even particular reaches. It includes a wide range of monitoring activities that assess as many watershed ecosystem indicators as is practical for volunteer monitors, using relatively simple methods:
2. **Impact Investigation (both point and non-point source):** An Impact Investigation is the collection of selected information to establish the nature and extent of the impact of point and non-point source pollution sources (wastewater treatment plants and other permitted discharges, and various land uses) on the stream's ecological health and aquatic life uses. It

includes a wide range of monitoring activities that assess as many of the physical, chemical, and biological indicators of stream health likely to be affected by these sources as is practical for volunteer monitors, using methods appropriate to the data uses and users.

3. **Use Support Investigation:** A Use Support Investigation involves documenting whether the waters support their “designated uses” (e.g. aquatic life, water contact recreation, etc.). The results are compared with the criteria in the water quality standards applicable to each use (from Water Quality Standards). These criteria specify minimum or maximum levels or ranges necessary to support the uses.
4. **Effectiveness Investigation:** The purpose of this Investigation is to assess the effectiveness of various types of watershed restoration and protection actions. This is tailored to the uses and values being restored or protected. Usually, it will focus on determining whether the condition of the water supports the uses and values to be restored or protected. It may also include activities that provide an early warning of problems before the use is directly affected. This would include an investigation to verify and calibrate a model.

These correspond to the purposes (A-D) listed above in “Identify Monitoring reason” Section. Further, these analyses can be done at different levels of rigor to meet the needs of the 3 different data uses described above: Education, advocacy or planning, and legal/regulatory. These are not hard and fast uses – they represent different spots along a continuum.

The combination of monitoring reason/analyses and data use defines an assessment type. Use the table below to tentatively identify an assessment type for each combination of monitoring reason and data uses you have. The results will be the foundation for the remaining planning steps in this series.

| Study Purpose(s)                            |                  | Data Use(s)   |   |   |
|---|------------------|---|---|---|
|   |                  | I<br>Education/<br>Community Inquiry  | II<br>Community or Agency<br>Advocacy/<br>Planning                                  | III<br>Regulatory/<br>Legal               |
| <b>A. Condition and Trend Investigation</b> |                  | <b>Assessment A-I</b><br>General background information                                     | <b>Assessment A-II</b><br>Watershed Management Planning; 305(b) report              | N/A1                                      |
| <b>B. Impact Investigation</b>              | Non Point Source | <b>Assessment B-I</b><br>Educate community or students about pollution impacts              | <b>Assessment B-II</b><br>Identify impacts for remediation                          | <b>Assessment B-III</b><br>CWA Violations |
|   | Point Source     | <b>Assessment B-IV</b><br>Educate community or students about pollution impacts             | <b>Assessment B-V</b><br>Identify impacts for remediation                           | <b>Assessment B-VI</b><br>CWA Violations  |
| <b>C. Effectiveness Investigation</b>       |                  | <b>Assessment C-I</b><br>Educate students about effectiveness of BMPs, restoration projects | <b>Assessment C-II</b><br>Evaluation of effectiveness of BMPs, restoration projects |   |
| <b>D. Use Support Investigation</b>         |                  | <b>Assessment D-I</b><br>Community or student education about use impacts                   | <b>Assessment D-II</b><br>Watershed Management Planning; 303(d) report              | <b>Assessment D-III</b><br>CWA violations |

<sup>1</sup>N/A here is because the audience for trend and condition information is not usually regulatory or legal, regulatory or legal entities may indeed use trend and baseline information but not as the regulatory or legal endpoint-usually trend/baseline information lead to specific regulatory/legal endpoints. If this is not true for you A-III is your assessment type, there are no examples further in this text for A-III.

The amount of rigor increases usually from Type I to III. However, any data or information generated for Type III can be used for a II or I. Usually, this is not the case for I, it cannot be used for a II or III or will fulfill the information needs of a II or III.

**Identify all appropriate Assessment Types (combinations of monitoring reason(s) and data use(s)) for lakes.**

COMING SOON!

**Identify all appropriate Assessment Types (combinations of monitoring reason(s) and data use(s)) for wetlands.**

COMING SOON

**Relevance Check against Organizational Resources**

There are some factors to consider before committing to a particular Assessment Type, those include:

- ✓ Resources and Time, identify the potential hurdles of cost, logistics and overlapping expectations before resources are expended. Evaluate these against organizational mission, values and resources. Is there anything the organization needs to develop, if so add to your Action plan.
- ✓ Variability, water body variability with space and time, background or natural variability, variability and time aspect associated with land use/water practices need to be considered
- ✓ Regulatory requirements may or may not be relevant. Many existing regulatory processes depend upon monitoring data but may or may not use data for other purposes
- ✓ Shared Monitoring Efforts and or existing data and resources, can save resources, increase credibility and leverage impact. Phase 1, Step 2 included an information and relationship inventory. If you find existing data, employ a quality check before using, see Step 2 Resource Guide.

After this relevance check, re-select or re-prioritize Assessment Types or if necessary.

**Case Study 1:**

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**Case Study 2:**

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## References

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*California Watershed Assessment Manual Draft*, [http://cwam.ucdavis.edu/Manual\\_chapters.htm](http://cwam.ucdavis.edu/Manual_chapters.htm), Chapter 8.

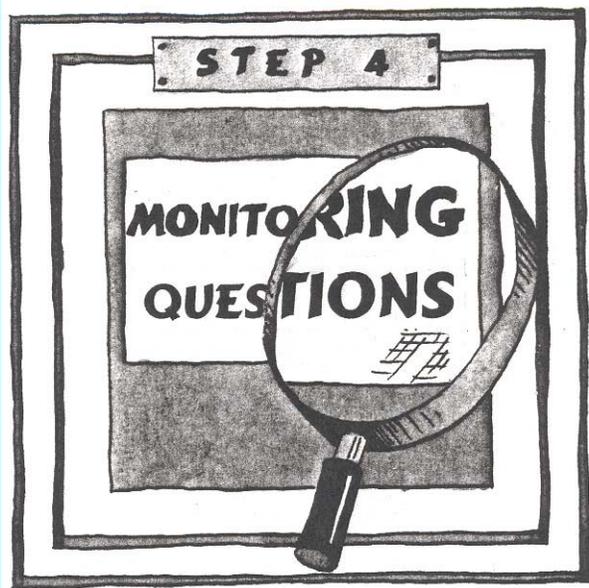
## Resources

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# PHASE I PEOPLE DESIGN



## Step 4: Develop Monitoring Questions (Refinement of Monitoring Reason)



“We are the product of an environment that is disconnected from the natural world, the one we evolved to be part of, and we are suffering and collective post-traumatic stress. We may not suffer the same way as my neighbor but he grew up in a culture that does not allow him to experience connection to people, animals, stars and the tides as he was meant to.”

**Chellis Glendinning**

**About This Step** - *This step is designed to accomplish:1 thing:*

---

1. For each Assessment Type, refinement of monitoring reasons through identifying monitoring questions. Monitoring question(s) are the questions you are trying to answer with data produced by each Assessment Type (combination of a data reason and data use) identified in Step 3.

### Why Do This Step?

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If you don't know the question(s) you are asking the data generated by the monitoring activity to answer, then how can you possibly know if it was answered, or that you might need more information to answer it? Collecting data without know what question you are trying to answer is similar to prescribing medicine for an ailment before you identify the ailment. How will you know if the treatment worked? First you need to identify specific questions to ask, eventually you want to identify the starting point to answer the question, “I know monitoring question A is met when...XYZ”. We will work on that in Step 5. The goal of this step is to help identify the monitoring questions.

It may be a somewhat confusing or feel premature to identify monitoring questions at this point. Actually identifying what questions you are asking your data to answer, or what question will fulfill

your monitoring reason is not premature at all, but essential in order to design an effective monitoring and assessment program.

The result of this step provides the basis for the sample or technical design as well as the foundation for evaluation. Did you generate the information you needed, not just data points.

In summary prior to this step, in Step 1 we used the Logic Model to illustrate and communicate how we plan to achieve a defined watershed vision. We identified outcomes or results that would indicate the watershed is moving toward the vision. We then identified activities and target audiences that would achieve those results or outcomes. From this list we identified outputs that were associated with monitoring or assessment. We then listed a general list of potential decision makers and decisions they make for each monitoring and assessment activity. In Step 2 we first identified our general information needs and then our watershed and water bodies focus. Next we evaluated what information existed in the watershed, what we needed and who might have it or be gathering it. This step synthesizes this information into combinations of monitoring reasons and data uses.

If you did not complete Phase 1, Steps 1 and 2, at a minimum you need to have identified the basic monitoring and assessment activities you are doing or are interested in. You need to know the watershed boundary and water bodies of interest and the overall outcomes the monitoring and assessment activities are supposed to support.

## Where are we in the Big Picture Illustration?

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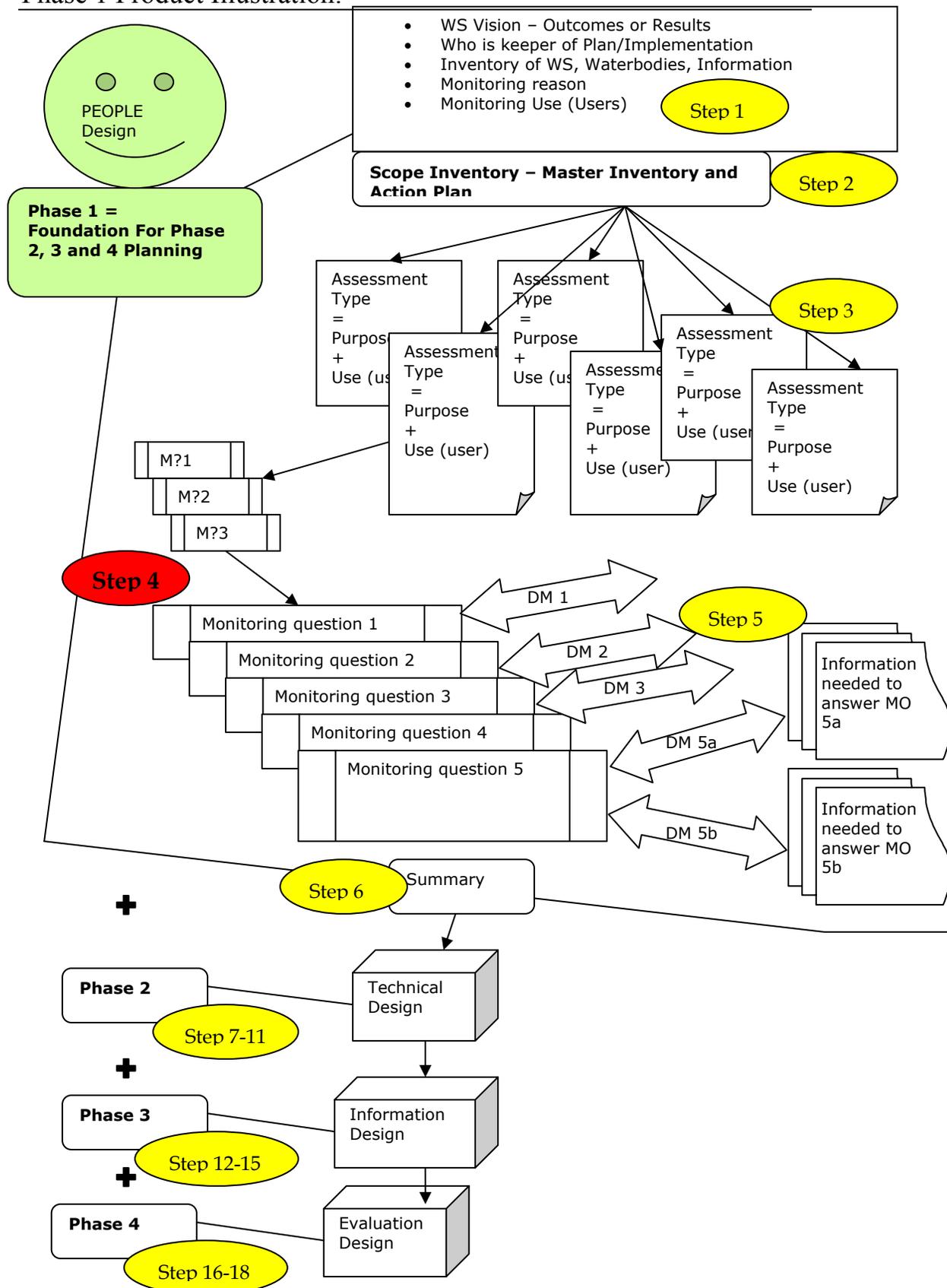
|         |  |
|---------|--|
| Phase 1 | Step 1: Share Watershed Vision and Desired Outcomes (Results)<br>Step 2: Scope Inventory (Physical, People and Information)<br>Step 3: Identify Monitoring Reason(s) and Data Use(s) (Assessment Type)<br> <b>Step 4: Develop Monitoring Questions (Refinement of Monitoring Reason)</b><br>Step 5: Target Decision Makers and Info Needs (Refinement of Data Use)<br>Step 6: Summarize with Information Blue Print-Data Pathway Fact Sheet |
| Phase 2 | Step 7: What Will You Monitor?<br>Step 8: When Will You Monitor?<br>Step 9: Where Will You Monitor?<br>Step 10: How Will You Monitor to Meet Data Quality Objectives?<br>Step 11: Management of Raw Data (Data Management Plan Part 1)   |
| Phase 3 | Step 12: Data Summary and Analysis<br>Step 13: Interpretation, Conclusions and Recommendations<br>Step 14: Communicating and Delivery<br>Step 15: Management to Generate Info (Data Management Plan Part 2)  |
| Phase 4 | Step 16: Who Will Do What? Task Identification<br>Step 17: Evaluation of Effectiveness (of Plan and Implementation)<br>Step 18: Documentation and Communication (of M & A Plan)  |

## Product (see Figure Phase1 Product List):

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- ✓ Refinement of “monitoring reason” for Assessment Type, a specific list of monitoring questions for each monitoring reason per Assessment Type.

Phase 1 Product Illustration:



## What Should Be Done Before This Step

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In Step 1 we used the Logic Model to illustrate and communicate how we plan to achieve a defined watershed vision. We identified outcomes or results that would indicate the watershed is moving toward the vision. We then identified activities and target audiences that would achieve those results or outcomes. From this list we identified outputs that were associated with monitoring or assessment. We then listed a general list of potential decision makers and decisions they make for each monitoring and assessment activity. In Step 2 we first identified our general information needs and then our watershed and water bodies focus. Next we evaluated what information existed in the watershed, what we needed and who might have it or be gathering it. This step synthesizes this information into combinations of monitoring reasons and data uses.

If you did not complete Phase 1, Steps 1 and 2, at a minimum you need to have identified the basic monitoring and assessment activities you are doing or are interested in. You need to know the watershed boundary and water bodies of interest and the overall outcomes the monitoring and assessment activities are supposed to support.

To complete this step an Assessment Type needs to be identified, or a specific combination of data reason and data use. In addition the specific water bodies of focus need to be identified. In theory the Assessment Types are linked to specific monitoring and assessment activities designed to achieve specific results or outcomes developed from a watershed vision (Step 1).

## Basic Tasks

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Basic Tasks are numbered to correlate with the overall 1-18 Steps provided in these guidance modules followed by the basic task sequence step to complete. For example Step 4, basic task 2 would be numbered as Basic Task Step 4.2, Step 3.3 correlates to Step 3, Basic Task 3.



4.1

Identify who will make the decisions about this step and who should be involved in the planning process (they may be different).



4.2

Self Assessment: Identify what decisions have been made and their effectiveness.



4.3

For each Assessment Type, a specific combination of one monitoring reason and data use(r), list all possible monitoring questions, or specific questions you need the data to answer to fulfill the assessment type monitoring reason and needs of the data use (user) that you know to date.



4.4

Update *Inventory Master List* and *Plan*.



4.5

Place Products in your *Watershed Monitoring and Assessment Plan*.



4.6

Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan).

## Worksheets

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Work sheets are listed below. Not all Basic Tasks have an associated work sheet. To simplify completion of products for each step, the worksheets or broken into small subsets of tasks. This requires moving the results of one task into the next task and will seem redundant, especially if completing worksheets by hand. Worksheets are provided in word here for ease of reproducibility. These are a starting point, we encourage you to customize these and reproduced them in an electronic format, in Excel for example, where it is easy to move information from one area to another by cutting and pasting.

Work Sheets are numbered to correlate with Basic Steps and the overall Steps in these guidance modules. Each consecutive work sheet is lettered a, b, c and so forth , preceded by the Basic Task sequence step, preceded by the Step number. For example, Worksheet Step 4.2.a and Step 4.2.b, correlates to Step 4, Basic Task 2, Worksheet a and Worksheet b. In theory worksheet a needs to be completed before worksheet b.

- Worksheet 4.2.a**      **Self Assessment Step 4 Worksheet and Products to be completed Prior to this Step, Part 1 and Part 2**
- Worksheet 4.3.a**      **Monitoring Question Worksheet per Assessment Type**
- Worksheet 4.5.a**      **Place Products in your *Watershed Monitoring and Assessment Plan***
- Worksheet 4.6.a**      **Final *Action Plan Part 1, Summary:***

## How to do Worksheets

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### **For Sheet 4.2.a Self Assessment: Identify what decisions have been made and their effectiveness.**

Part 1. Complete the self assessment section of the worksheet to evaluate what you have or what decisions have already been made. This will help you focus on what you need from this step and incorporate valuable existing information or products into this plan.

Part 2. Next, to prepare to complete this step the following, you need to have the following items addressed:

- √ Desired set of outcomes or results that the monitoring and assessment activities will be designed to help achieve
- √ Identified monitoring and assessment activities, specific combinations of a monitoring reason plus an associated data use; we call this an Assessment Type. You may have multiple Assessment Types.
- √ A minimal scoping inventory that identifies the watershed boundary and water bodies you are focusing on (rivers, lakes or wetlands), physical attributes of water bodies (including status, uses, etc.), relevant cultural or historical aspects, existing data sets or monitoring efforts and others in the watershed who either you want to influence or could help you implement.

This is the ideal list, if you do not have any of these, they become a gap or need that should be addressed before any data is collected or analyzed, even if the answers aren't perfect or you don't have a large degree of confidence surrounding them, they should be attempted as the starting point. This is what you are evaluating in this step-your monitoring and assessment plan.

### **Worksheet 4.2.a Self Assessment Step 4 Worksheet and Products to be completed Prior to this Step, Part 1.**

#### *Part 1 Self Assessment of Known Evaluation Products and Processes*

- 1. Determine if you "have" or "don't have" the item, mark the appropriate box. If you don't have it and determine you don't need it, explain why in the comments document. You may not need to know but perhaps your target decision makers, board or membership might want to know.**
- 2. If you have the item "documented", mark that box. If so, list in the comments where, hard copy, chapter in a document, electronic file name and location, etc. The assumption is you value the ultimate goal to document and communicate your M & A plan, activities and results.**
- 3. If you have the item, assess the use of it, use the scale below or provide your own answer and comments.**

Rating Scale for USE:

- 0=doesn't exist so use is nil
- 1=don't know why would need or understand item
- 2=exists, don't know where it is, if it is used, etc. so use is essentially nil
- 3=exists and use some of time
- 4=exists and use all the time
- 5=wish it existed, would use it lots

- 4. If you have the item, assess the effectiveness of it, just because something exists or is used does not mean it is effective in its use, use the effectiveness scale below or provide your own answer and comments.**

Rating Scale for EFFECTIVENESS, assumes material exists:

0=not effective or functional at all

1=incomplete (all elements are not there) and some existing parts need revising

2=incomplete but what is there is okay

3=complete (all elements are there), some parts okay but need revising

4=complete and effective

| Item  | Have | Don't Have | DOC | Assessment of Use (Scale 0-5) | Assessment of Value / Effectiveness (Scale 0-4) | Comments |
|---|------|------------|-----|-------------------------------|---|----------|
| 17. Identified, written, specific monitoring questions for each Assessment Type |      |            |     |                               |   |          |
| Other?  |      |            |     |                               |   |          |

\*DOC=Documentation, \*M & A= Monitoring and Assessment

- 5. To make this assessment useful, determine what your gaps and needs are regarding this step in order to focus your effort in completing this step.**

**Worksheet 4.2.a Self Assessment Step 4 Worksheet and Products to be completed Prior to this Step, Part 2.**

*Part 2 Products to be completed before this step, in order to complete this step*

| Item   | Response |
|--|----------|
| Desired set of outcomes or results that the monitoring and assessment activities will be designed to help achieve: |          |
| Assessment Types, specific combination of one monitoring reason and data use(r):                                   |          |
| For each Assessment Type, the list of specific monitoring questions, from Step 1 or 2:                             |          |
| Watershed(s) and Water bodies of focus:  |          |
| Physical attributes of Water bodies (status, use, etc.)  |          |
| Existing Data or monitoring efforts:   |          |

**For Sheet 4.3.a**

**For each Assessment Type, a specific combination of one monitoring reason and data use(r), list all possible monitoring questions, or specific questions you need the data to answer to fulfill the assessment type monitoring reason and needs of the data use (user) that you know to date.**

**Worksheet 4.3.a Monitoring Question Worksheet per Assessment Type**

*Articulate each monitoring question per Assessment Type. The next step, Phase 1 Step 5 will have you complete the far right box, "Will be answered by:", it is here so you can see where you are going. Start with any monitoring questions you listed in Steps 1-3 of Phase 1. Edit or modify datasheet to suit your needs.*

| Assessment Type: ____                     | Reason (Step 3):            | Use (Step 3): |
|---|-----------------------------|---------------|
| <b>Monitoring question:</b> ____ of ____: | <b>Will be answered by:</b> |               |
| <b>Monitoring question:</b> ____ of ____: | <b>Will be answered by:</b> |               |
| <b>Monitoring question:</b> ____ of ____: | <b>Will be answered by:</b> |               |
| <b>Monitoring question:</b> ____ of ____: | <b>Will be answered by:</b> |               |
| <b>Monitoring question:</b> ____ of ____: | <b>Will be answered by:</b> |               |
| <b>Monitoring question:</b> ____ of ____: | <b>Will be answered by:</b> |               |

**For Sheet 4.5.a** Place Products in your *Watershed Monitoring and Assessment Plan*

➡ All monitoring questions per Assessment Types

**Worksheet 4.5.a** Place Products in your *Watershed Monitoring and Assessment Plan*

I. People Design, Phase 1

- A. Shared Watershed Vision and Desired Outcomes (Step 1)
  - 1. Logic Model of Desired Outcomes/Results and activities/target audiences to employ to achieve outcomes
- B. Keepers of the M & A Plan (Step 1)
- C. Watershed Boundary (Step 2)
- D. Water bodies of Interest (Step 2)
- E. Scope Inventory Master List\* (Step 2)
  - 1. Physical Inventory \* (Step 2)
  - 2. People Inventory\* (Step 2)
  - 3. Information Inventory\* (Step 2)
    - a. Existing Monitoring Efforts (Step 2)
    - b. Existing Data Sources (Step 2)
  - 4. Inventory Action Plan\* (Step 2)
- F. Assessment Type(s) List – Monitoring Reason + Use (Step 3)
  - 1. ➡ Monitoring Question(s) (Step 4)
  - 2. Targeted Decision Maker(s) (Step 5)
    - a. Information Needs (Step 5)
  - 3. Information Blue Print – Data Pathway Fact Sheet Per Monitoring Question\* (Step 6)

II. Technical Design, Phase 2

- A. What (Indicators, Benchmarks, etc.) and why? (Step 7)
- B. When and why? (Step 8)
- C. Where and why? (Step 9)
- D. W(how) will meet data quality objectives? (Step 10)
  - 1. Data quality objectives (Step 5 and 10)

2. Quality Assurance and Control Measures (Quality Assurance and Control Plan)\* (Step 10)
- E. Data Management for Raw Data (Data Management Plan Part 1)\* (Step 11)

### III. Information Design, Phase 3

- A. Data Summary and Analyses (Step 12)
  1. Starting Point (Step 12)
  2. Changes (Later)
- B. Data Interpretation, Conclusions, Recommendations
  1. Starting Point (Step 13)
  2. Changes (Later)
- C. Communication and Delivery
  1. Starting Point (Step 14)
  2. Changes (Later)
- D. Management Plans to Generate Information (Data Management Plan Part 2)\* (Step 15)

### IV. Evaluation Design, Phase 4

- A. Who Will Do What? (Step 16)
  1. Task Identification Matrix (Step 16)
  2. Communication Structure and Tools (Step 16)
- B. Evaluation Plans (Step 17)
  1. Evaluation Plans for M & A Components (Step 17)
  2. Evaluation Plans for M & A Implementation (Step 17)
  3. Evaluation of inter/intra M & A Activities (Step 17)
- C. Documentation and Communication (Step 18)
  1. M & A Plan (**this document**, updated Sub documents) (Step 18)
  2. Communication and Peer Review Plan (Step 18)
  3. Action Plan\* (Step 17)

**For Sheet 4.6.a**      **Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan).**

**Worksheet 4.6.a**      **Final *Action Plan* Part 1, Summary:**

*If you have completed each Step, or for those you have, you have a cumulated list of gaps and needs related to that Step. Use that same worksheet/document. If you did not complete each Step, look at what each Step is supposed to accomplish and record what your gaps and needs are related to that topic. The goals are to get the gaps and needs in one place to evaluate and prioritize.*

|  |
|--|
| <b>Phase 1 Step 1: (completed in Step 1)</b>   |
| <b>Phase 1 Step 1: (completed in Step 2)</b>   |
| <b>Phase 1 Step 1: (completed in Step 3)</b>   |
| <b>Phase 1 Step 4:</b>   |
|  |
| <b>Phase 2, 3 and 4 Steps: Will add Action and Needs as complete each Step and at the end prioritize</b> |
|  |

## Background and Content

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Identify all Relevant Monitoring questions for Each Assessment Type and specific data reason and use combination.

*What are Monitoring questions or Questions?*

The goal of this step is to be able to identify specific monitoring questions are questions your are asking the data generated to answer, that will fulfill the monitoring reason and data use or Assessment Type. First we need to understand what are accurate or adequate monitoring questions or questions. Second, we need to identify all possible monitoring questions each Assessment Type needs to answer, and Third how we plan to answer each monitoring question, with what information. The results of this step deepen our foundation to design an adequate monitoring plan.

In Step 2, you generated a list of information that might be or needed to be generated from the identified monitoring and assessment activities in order to achieve desired decisions, results or outcomes. This was completed in Basic Task Step 2.3.3. This list can be a starting point for this step. You can take this list and morph the information into a question that monitoring data will answer. The following table provides some examples of possible monitoring questions.

### Examples of Monitoring questions

#### Human Health Related

- To assess whether bacteria levels are safe for swimming in the lake.
- To identify sources of bacteria contamination.
- To determine the impacts of specific pollution sources on bacteria levels
- To determine whether bacteria reduction actions are working.
- To determine the lake's natural background conditions and the range of natural variability in order to establish benchmarks.

#### Aquatic Life Related

- To assess the current biological integrity of the benthic macroinvertebrate community
- To identify sources of pollution or habitat alteration that are degrading the biological integrity of the benthic macroinvertebrate community
- To determine the impacts of specific pollution or habitat alteration sources on the benthic macroinvertebrate community
- To determine whether impact reduction actions are working.
- To determine natural background levels of aquatic life stressors and aquatic life communities, and their range of natural variability in order to establish benchmarks for the lake's aquatic life health.

In general, each monitoring reason as a generic set of monitoring questions:

**Condition Trend:** Is there a change from existing conditions in XYZ? Is there a change from historic or reference conditions? Is there an unacceptable deviation from ABC criteria? What are limiting factors?

**Impact:** Is water body A affected by land use practice B?

**Effectiveness:** Did restoration/BMP Y work? If so why, if not why not?

**Use Support:** Is it safe to swim in water body X? Are fish dying in water body Y? What is desired or potential condition?

Often, in the planning stages, existing condition and potential limiting factors are evaluated through a review of existing data, field reconnaissance or individuals knowledge. Limiting factors include both direct factors, such as temperature and indirect factors such as streamside vegetation which has an

indirect influence on stream temperature. Some synopsis of what is known about the existing condition, limiting factors and desired future condition should be conducted.

Thus, the task is to take each Assessment Type and specific monitoring reason and use and identify all monitoring questions. Start with asking your self, "I have this monitoring need or reason and a supposed use, what do I want really want to know, want someone else to know?" Take that first cut of questions and work them to be specific questions. The work is in the doing here. Do your best with what you know right now.

Case Study 1:

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Case Study 2:

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## References

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## Resources

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Contents in Phase 1, Step 4 Resource Guide:

# PHASE I PEOPLE DESIGN



## Step 5: Target Decision Makers and Information Needs (Refinement of Data Use)



“For the first time in human history, stores are not told by the parent or by the church or by the community or even by the native country, but by a handful of media conglomerates that have nothing to tell but a lot to sell.”

**George Gerbner**

**About This Step** – *This step is designed to accomplish 6 things:*

1. For each monitoring question, generated in Step 4, refine the data use (users) part of you Assessment Type and produce a list of possible decision makers to target and articulate the decision you want them to make.
2. For each decision maker and possible decision, determine how the decision is made and identify what information is needed to make the decision(s). These are called information needs and will be used as the foundation for development of the technical design (Phase 2), Information Design (Phase 3) and Evaluation Design (Phase 4).
3. Introduce Data Quality Objectives or acceptance and performance criteria for the collection, evaluation and use of environmental data.
4. For each monitoring question identify what you know now as the starting point to answer the question, “I know Monitoring Question A will be answered when XYZ...”. If you define XYZ you accomplished this step. You may need to complete Phase 2 and 3 to finalize these questions. If you do know the answers to all your XYZ’s, the planning for Phase 2 and 3 is much easier.
5. Determine ambiguous terms that are associated with your Assessment Type, monitoring reason and question.

6. elect and prioritize targeted decision makers, data users (for data uses) based upon organizational capacity.

## Why Do This Step?

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To this point we have identified what questions we want to answer (monitoring questions), for what purpose and what data uses. We have addressed to the best of our ability how those questions will be answered. We will complete that task here as well as identify specifically who will answer these monitoring questions.

We are expanding on the data use part of the assessment type, the data users, by identifying and targeting specific decision makers or data users. Furthermore, we articulate what decision we want them to make, how they make it and what information they need to make it. This information provides the foundation and orientation for our monitoring, analyses, reporting and evaluation plans (Phase 2 through 4).

The information needs of the targeted decision maker(s) will dictate, at a minimum, where you will sample, when you will sample, what you will sample and how, data quality necessary, how data needs to be stored, analyzed, interpreted and reported. Most importantly how you will know when your monitoring questions/questions are answered, how your outputs have moved you forward towards your outcomes and watershed vision.

Included in a decision makers information needs is the concept of data quality objectives. What? Data quality objectives are defined acceptance and performance criteria predetermined for the collection, evaluation and use of specific environmental data. What you ask? They identify the “level of performance” for each indicator. For example if you are measuring pH, do you need a pH meter with two calibration points or litmus paper? For iron, is a detection limit of 1000 mg/l ok or do you need more precision? Data quality objectives are good for any monitoring and assessment purpose/use, but essential for those that compare alternatives, such as pre/post, above/below, historic/current, etc. This is important information to know about your decision maker and for sample gathering and analyses.

The result of this step is completes the stage to define the data pathway for every monitoring question, the path each data point will travel to become information and be delivered. This pate is the blue print for generating information. With such a blue print, you can evaluate monitoring and assessment activities, this is the focus of the next step, Step 6.

## Where are we in the Big Picture Illustration?

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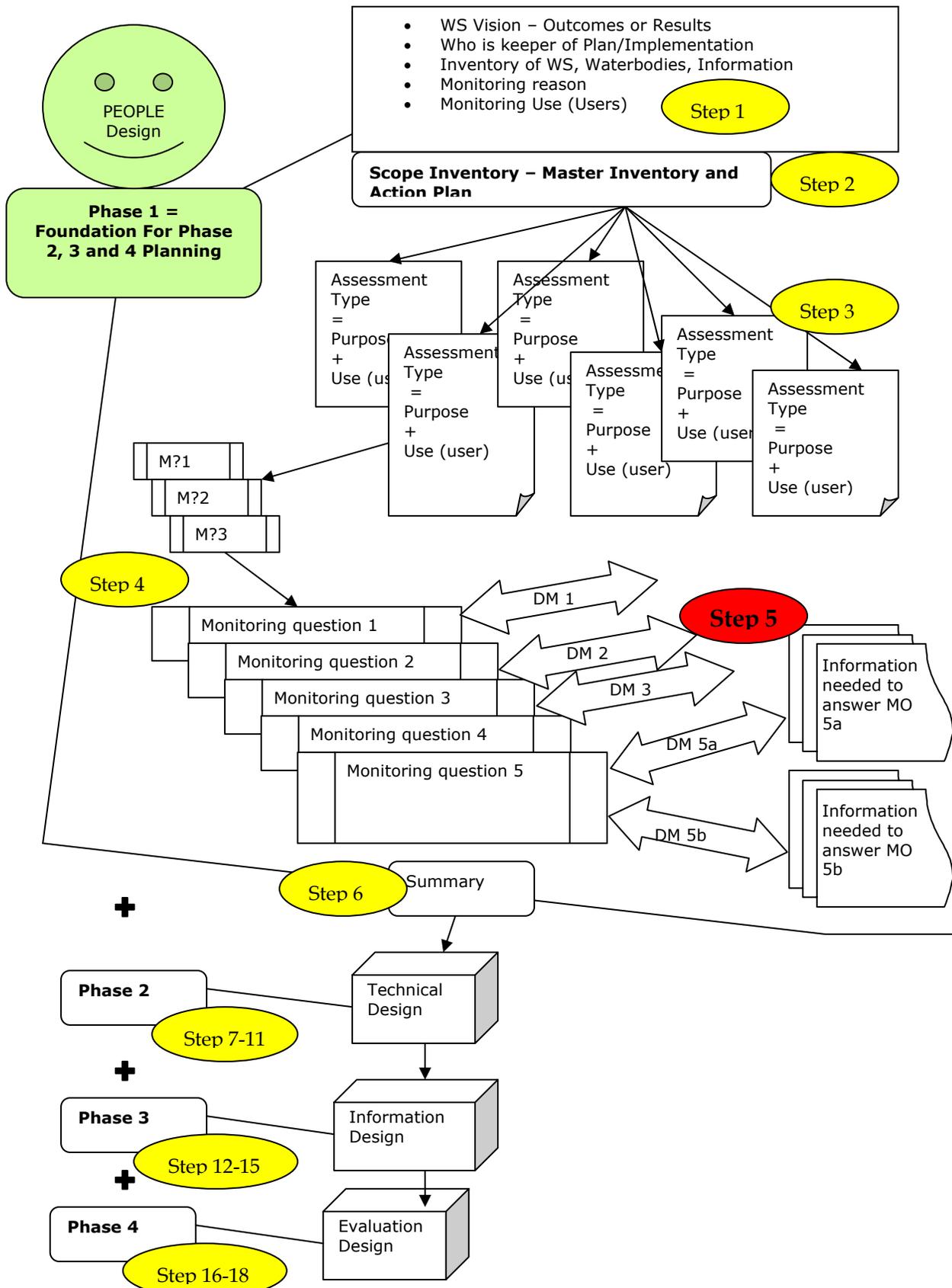
|         |  |
|---------|--|
| Phase 1 | Step 1: Share Watershed Vision and Desired Outcomes (Results)<br>Step 2: Scope Inventory (Physical, People and Information)<br>Step 3: Identify Monitoring Reason(s) and Data Use(s) (Assessment Type)<br>Step 4: Develop Monitoring Questions (Refinement of Monitoring Reason)<br> <b>Step 5: Target Decision Makers and Info Needs (Refinement of Data Use)</b><br>Step 6: Summarize with Information Blue Print-Data Pathway Fact Sheet |
| Phase 2 | Step 7: What Will You Monitor?<br>Step 8: When Will You Monitor?<br>Step 9: Where Will You Monitor?<br>Step 10: How Will You Monitor to Meet Data Quality Objectives?<br>Step 11: Management of Raw Data (Data Management Plan Part 1)   |
| Phase 3 | Step 12: Data Summary and Analysis<br>Step 13: Interpretation, Conclusions and Recommendations<br>Step 14: Communicating and Delivery<br>Step 15: Management to Generate Info (Data Management Plan Part 2)  |
| Phase 4 | Step 16: Who Will Do What? Task Identification<br>Step 17: Evaluation of Effectiveness (of Plan and Implementation)<br>Step 18: Documentation and Communication (of M & A Plan)  |

## Product (see Figure Phase1 Product List):

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- ✓ For each monitoring question a potential and selected list of decision makers to target and what decision they would make. This is completed for every monitoring question for each Assessment Type.
- ✓ For each decision maker and associated decision, a description of how the decision is made and what information is needed by the decision maker to make the decision. Might require asking them. Provides data for information blueprint.
- ✓ Start Data Quality Objectives or acceptance and performance criteria for the collection, evaluation and use of environmental data.
- ✓ Complete list of monitoring questions and a start on how each one will be answered.
- ✓ Definitions for ambiguous terms such as “clean” or “restored” associated with this Assessment Type monitoring reason and question.

Phase 1 Product Illustration:



## What Should Be Done Before This Step

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If you don't know the question(s) you are asking the data generated by the monitoring activity to answer, then how can you possibly know if it was answered, or that you might need more information to answer it? Collecting data without know what question you are trying to answer is similar to prescribing medicine for an ailment before you identify the ailment. How will you know if the treatment worked? Thus, you need specific monitoring questions or every combination of data reason and use (assessment type). In this step you will identify the starting point to answer the each question, "I know monitoring question A is met when...XYZ". We will work on that in Step 5.

In summary prior to this step, in Step 1 we used the Logic Model to illustrate and communicate how we plan to achieve a defined watershed vision. We identified outcomes or results that would indicate the watershed is moving toward the vision. We then identified activities and target audiences that would achieve those results or outcomes. From this list we identified outputs that were associated with monitoring or assessment. We then listed a general list of potential decision makers and decisions they make for each monitoring and assessment activity. In Step 2 we first identified our general information needs and then our watershed and water bodies focus. Next we evaluated what information existed in the watershed, what we needed and who might have it or be gathering it. This step synthesis this information into combinations of monitoring reasons and data uses.

If you did not complete Phase 1, Steps 1 and 2, at a minimum you need to have identified the basic monitoring and assessment activities you are doing or are interested in. You need to know the watershed boundary and water bodies of interest and the overall outcomes the monitoring and assessment activities are supposed to support.

## Basic Tasks

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Basic Tasks are numbered to correlate with the overall 1-18 Steps provided in these guidance modules followed by the basic task sequence step to complete. For example Step 4, basic task 2 would be numbered as Basic Task Step 4.2, Step 3.3 correlates to Step 3, Basic Task 3.



5.1 Identify who will make the decisions about this step and who should be involved in the planning process (they may be different).



5.2 Self Assessment: Identify what decisions have been made and their effectiveness.



5.3 First tier, for each monitoring question (corresponding to an Assessment Type), generated in Step 4, list all potential decision makers and articulate the decision(s) they could make or not make (related to that monitoring question). If this list is large, you can prioritize before proceeding to the next step.



5.4 Second Tier, for each decision-maker and their possible decision, identify how they make the decision and what information they need/use to make the decision. Include data quality objectives, especially if your assessment type includes using data to test between to alternative scenarios (just as pre/post, above/below, past/present).



5.5 If can, for each monitoring question answer the question: “I know the monitoring question A will be answered by XYZ.” If you cannot, give it your best shot, Phase 2 and 3 will guide you through a final determination.



5.6 Define any Ambiguous terms associated with each Assessment Type monitoring reason and question.

Define any ambiguous terms in your monitoring question. Ambiguous terms are any terms that can have multiple meanings depending upon the reader. It is not so important they your definition is right or wrong but that terms are defined. Readers can decide for themselves if that meaning matches their needs.



5.7 Prioritize and Select which decision makers you will target based upon organizational capacity.

At this point you want to evaluate what decision-makers you can or want to influence and commit to those associated monitoring questions. You may not be able to conduct all the possible monitoring desired. You will need to go backwards here, check in with the previous steps and calibrate accordingly. You can document what you decided not to do and why as well. That might be valuable for institutional knowledge and relate to assumptions and external factors you listed in the logic model.

Note, it is common for the information needs of decision makers and the realistic information that a monitoring system can actually produce are often not the same. Knowing this ahead of time clarifies expectations and wasted resources. You may not discover this until you have address components in all four Phases.

In asking your decision makers how they use specific data, be prepared for your decision makers to say, “We need all the data, we need everything you have” and not be able to tell you how they use it or how the decision is made. In this case we recommend you craft an information expectation, “this specific data will be used, in such and such analyses, to answer xyz monitoring questions.” Let them edit something you create if they can’t produce it.



5.8

Update *Inventory Master List* and *Plan*.



5.9

Place Products in your *Watershed Monitoring and Assessment Plan*.



5.10

Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan).

## Worksheets

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Work sheets are listed below. Not all Basic Tasks have an associated work sheet. To simplify completion of products for each step, the worksheets or broken into small subsets of tasks. This requires moving the results of one task into the next task and will seem redundant, especially if completing worksheets by hand. Worksheets are provided in word here for ease of reproducibility. These are a starting point, we encourage you to customize these and reproduced them in an electronic format, in Excel for example, where it is easy to move information from one area to another by cutting and pasting.

Work Sheets are numbered to correlate with Basic Steps and the overall Steps in these guidance modules. Each consecutive work sheet is lettered a, b, c and so forth , preceded by the Basic Task sequence step, preceded by the Step number. For example, Worksheet Step 4.2.a and Step 4.2.b, correlates to Step 4, Basic Task 2, Worksheet a and Worksheet b. In theory worksheet a needs to be completed before worksheet b.

- Worksheet 5.2.a**      **Self Assessment Step 5 Worksheet and Products to be completed Prior to this Step, Part 1 and Part 2**
- Worksheet 5.3.a**      **Possible Decision Maker and Decision for each Monitoring Question**
- Worksheet 5.4.a**      **Information needs of each Targeted Decision Maker**
- Worksheet 5.4.b**      **Data Quality Objectives for each Targeted Decision Maker/Indicator**
- Worksheet 5.5.a**      **Monitoring Question will be answered by XYZ”**
- Worksheet 5.6.a**      **Definitions for Ambiguous Terminology for each Monitoring Question**
- Worksheet 5.9.a**      **Place Products in your *Watershed Monitoring and Assessment Plan***
- Worksheet 5.10.a**    **Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan)**

## How to do Worksheets

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### **For Sheet 5.2.a Self Assessment Step 5 Worksheet and Products to be completed Prior to this Step.**

Part 1. Complete the self assessment section of the worksheet to evaluate what you have or what decisions have already been made. This will help you focus on what you need from this step and incorporate valuable existing information or products into this plan.

Part 2. Next, to prepare to complete this step the following, you need to have the following items addressed:

- √ Desired set of outcomes or results that the monitoring and assessment activities will be designed to help achieve
- √ Identified monitoring and assessment activities, specific combinations of a monitoring reason plus an associated data use; we call this an Assessment Type. You may have multiple Assessment Types.
- √ For each Assessment Type, the list of specific monitoring questions the monitoring and assessment will be designed to answer.
- √ A minimal scoping inventory that identifies the watershed boundary and water bodies you are focusing on (rivers, lakes or wetlands), physical attributes of water bodies (including status, uses, etc.), relevant cultural or historical aspects, existing data sets or monitoring efforts and others in the watershed who either you want to influence or could help you implement.

This is the ideal list, if you do not have any of these, they become a gap or need that should be addressed before any data is collected or analyzed, even if the answers aren't perfect or you don't have a large degree of confidence surrounding them, they should be attempted as the starting point. This is what you are evaluating in this step-your monitoring and assessment plan.

**Worksheet 5.2.a Self Assessment Step 5 Worksheet and Products to be completed Prior to this Step, Part 1.**

*Part 1 Self Assessment of Known Evaluation Products and Processes*

- 1. Determine if you “have” or “don’t have” the item, mark the appropriate box. If you don’t have it and determine you don’t need it, explain why in the comments document. You may not need to know but perhaps your target decision makers, board or membership might want to know.**
- 2. If you have the item “documented”, mark that box. If so, list in the comments where, hard copy, chapter in a document, electronic file name and location, etc. The assumption is you value the ultimate goal to document and communicate your M & A plan, activities and results.**
- 3. If you have the item, assess the use of it, use the scale below or provide your own answer and comments.**

Rating Scale for USE:

- 0=doesn’t exist so use is nil
- 1=don’t know why would need or understand item
- 2=exists, don’t know where it is, if it is used, etc. so use is essentially nil
- 3=exists and use some of time
- 4=exists and use all the time
- 5=wish it existed, would use it lots

- 4. If you have the item, assess the effectiveness of it, just because something exists or is used does not mean it is effective in its use, use the effectiveness scale below or provide your own answer and comments.**

Rating Scale for EFFECTIVENESS, assumes material exists:

- 0=not effective or functional at all
- 1=incomplete (all elements are not there) and some existing parts need revising
- 2=incomplete but what is there is okay
- 3=complete (all elements are there), some parts okay but need revising
- 4=complete and effective

| Item   | Have | Don't Have | DOC | Assessment of Use (Scale 0-5) | Assessment of Value / Effectiveness (Scale 0-4) | Comments |
|--|------|------------|-----|-------------------------------|---|----------|
| 18. List of targeted decision-makers   |      |            |     |                               |   |          |
| 19. For targeted decision-makers, knowledge of what information they need, see list in Phase 1, Step 5 |      |            |     |                               |   |          |
| 20. For targeted decision makers identified data quality objectives?                                   |      |            |     |                               |   |          |
| Other?   |      |            |     |                               |   |          |

\*DOC=Documentation, \*M & A= Monitoring and Assessment

- 5. To make this assessment useful, determine what your gaps and needs are regarding this step in order to focus your effort in completing this step.**

**Worksheet 5.2.a Self Assessment Step 5 Worksheet and Products to be completed Prior to this Step, Part 2.**

*Part 2 Products to be completed before this step, in order to complete this step*

| Item   | Response |
|--|----------|
| Desired set of outcomes or results that the monitoring and assessment activities will be designed to help achieve:   |          |
| Assessment Types, specific combination of one monitoring reason and data use(r):   |          |
| For each Assessment Type, the list of specific monitoring questions:   |          |
| For each monitoring question, the targeted decision makers, the type of decisions they will make and the information they need to make them (as specific as possible): |          |
| Watershed(s) and Water bodies of focus:  |          |
| Physical attributes of Water bodies (status, use, etc.)  |          |
| Existing Data or monitoring efforts:   |          |

**For Sheet 5.3.a**      **First tier, for each monitoring question (corresponding to an Assessment Type), generated in Step 4, list all potential decision makers and articulate the decision(s) they could make or not make (related to that monitoring question). If this list is large, you can prioritize before proceeding to the next step.**

Refer to Worksheet 4.3.a for list of monitoring questions per Assessment Type. Now you are ready to inventory and determine who are the decision makers most relevant to your desired outcomes, Assessment Type and associated monitoring reason(s) and question(s). This is an important exercise. This worksheet is designed to help you think outside the box and list all relevant decision makers. You don't have to commit to each one, however you need to leave this step knowing who you are committed too. It is this chosen list of decision makers and the information they need to make the decision you want that is the foundation for Phase 2 and 3 designs.

The goal is to have a set of targeted decision makers for each monitoring question per Assessment Type. You may have one decision maker for each question, you may have ten, you may have a different set for each question. You need to know who you are generating information for so you can determine what to generate, when, where and how. In addition, how it needs to be delivered, what needs to be delivered, etc.

Remember decision-makers is anyone you intend to use the data, results and information generated, including you. You may discover that your decision maker does not have a clear decision making process at all, but a decision is made. You might be the decision maker and have no idea what your information needs are. You can borrow from other experts, assessment efforts and a sample designs. The point is, if you don't determine this upfront, you have nothing to evaluate.

Once the list is complete, if it is too large, prioritize it. In Step 6 you will complete a cost estimate for each monitoring question and evaluate all monitoring questions and Assessment Types with your organizational capacity. Right now, focus on gathering the information.

**Worksheet 5.3.a Possible Decision Maker and Decision for each Monitoring Question**

For each Monitoring Question per Assessment Type, identify the possible decision makers and the decision they make that you might want to target. Prioritize, you don't have to target everyone, but know the ones that are your focus. Decision maker is anyone who was intended to use the data, results and information generated, including you. Modify table to meet your needs.

|  |                       |                         |                      |
|--|-----------------------|-------------------------|----------------------|
| <b>Assessment Type:</b> ____                       |                       | <b>Reason (Step 3):</b> | <b>Use (Step 3):</b> |
| <b>Monitoring question (step 4):</b> ____ of ____: |                       |                         |                      |
| <b>Id #</b>  | <b>Decision Maker</b> | <b>Decision Make:</b>   |                      |
|  |                       |                         |                      |
|  |                       |                         |                      |
|  |                       |                         |                      |
|  |                       |                         |                      |
| <b>Monitoring question:</b> ____ of ____:          |                       |                         |                      |
|  |                       |                         |                      |
|  |                       |                         |                      |
|  |                       |                         |                      |
|  |                       |                         |                      |
| <b>Monitoring question:</b> ____ of ____:          |                       |                         |                      |
|  |                       |                         |                      |
|  |                       |                         |                      |
|  |                       |                         |                      |
|  |                       |                         |                      |
|  |                       |                         |                      |
|  |                       |                         |                      |

**For Sheet 5.4.a**      **Second Tier, for each decision-maker and their possible decision, identify how they make the decision and what information they need/use to make the decision. Include data quality objectives, especially if your assessment type includes using data to test between to alternative scenarios (just as pre/post, above/below, past/present).**

From Worksheet 5.4.a you have a selected list of decision makers you choose to target at this point. Use that list to determine the information needed by each of those decision makers to make the decision you desire and answer the monitoring question.

There is no simple way to capture this list of information needs, but it does need to be captured. It is this chosen list of decision makers and the information they need to make the decision you want that is the foundation for Phase 2 and 3 designs. Make an outline like below or a spreadsheet or some other mechanism to capture the tree limbs of decision maker, decision they will make, how make it and information need to make – for every monitoring question.

You may discover that your decision maker does not have a clearly defined information needs, but a decision is made. You might be the decision maker and have no idea what your information needs are. You can borrow from other experts, assessment efforts and a sample designs. The point is, if you don't determine this upfront, you have nothing to evaluate. Complete what you can. Phase 2 and 3 will help you define what you don't know. This will help you narrow the questions you need to answer.

Before the plan is complete, the goal is to be able to answer the question "My monitoring question A will be answered by XYZ", as a starting point. In addition, by answer this for all monitoring questions you have the foundation to build a technical, data-to-information and evaluation design that will provide the data to answer the monitoring question.

**For Sheet 5.4.b**      **Identify data quality objectives for each selected targeted decision maker.**

Data quality objectives are the performance measures you need to make sure the data generated is of sufficient quality for decision makers to make the decision. Quality assurance and control plans are programs, processes, procedures, samples and the like that are implement to meet data quality objectives. A data quality objective for example might be that pH must be measured to the 10ths and not ones. That means that you cannot use litmus paper but need some sort of meter.

Data quality objectives should be defined to some degree for every monitoring program. If your Assessment Type is one that will choose between alternative 1 or 2, such as a pre or post clean up, above or below an impact or with historic versus current, you must define data quality objective for credibility and decision making.

**Worksheet 5.4.a Information needs of each Targeted Decision Maker**

Answer the following questions for each decision maker per monitoring question as specific as possible. You can make this one data sheet per decision maker versus two if need more room, edit to serve your needs.

| Assessment Type: ____   | Reason (Step 3):     | Use (Step 3):        |
|---|----------------------|----------------------|
| Monitoring question (step 4): ____ of ____:                                       |                      |                      |
| Info Need:  | Decision Maker ____: | Decision Maker ____: |
| Decision Make?  |                      |                      |
| Key processes, natural/political?   |                      |                      |
| Key Indicators needed, in what media?   |                      |                      |
| Where do they need it from (key locations, political, historical, etc.)?          |                      |                      |
| Benchmarks and references they use, criteria, metrics, indexes, statistics, etc.? |                      |                      |
| What frequency/duration (length of record) does information need to be?           |                      |                      |
| How “good” does it have to be (peer reviewed, certain methods, etc.) be?          |                      |                      |
| Methods are they using, need you to use, field/lab                                |                      |                      |
| What acceptance/performance criteria do they use?                                 |                      |                      |

# Phase 1: People Design: Build a Foundation | Step 5: Target Decision Makers, Page 17

|   |  |  |
|---|--|--|
| Information needs to be included besides data or information, meta data?                              |  |  |
| Will you deliver, raw data, analyzed, interpreted, conclusions, recommendations, where will you exit? |  |  |
| Do they need you to analyze, interpret, conclude or recommend   |  |  |
| Is the decision made? Process, formal, legal, rigorous, opportunities                                 |  |  |
| Do they need the information, format?   |  |  |
| Will it be delivered, mail, meeting, hearing, orally, etc.?   |  |  |
| Is the decision made?   |  |  |
| Do they need the data or information at what frequency?   |  |  |
| Will deliver the data and then evaluate if decision was made and role of information?                 |  |  |



**For Sheet 5.5**

**If can, for each monitoring question answer the question: “I know the Monitoring Question A will be answered by XYZ.” If you cannot, give it your best shot, Phase 2 and 3 will guide you through a final determination.**

Your goal to complete this plan is to answer this for every monitoring question/ Assessment Type: “My monitoring question A will be answered by XYZ”. In theory, each of your decision makers needs to answer this question as well in order to make the decision. It seems simple and black and white and of course it is not. The point is not to be right or wrong, but to an answer to start, that is what forms the basis for evaluation.

The point is to have the best answer you can when you start. Regardless of the level of a decision maker (education to rigorous compliance) this is what is done. The answer may evolve with implementation, plan adjustments and continuous iterations, but each question is answered formally or informally. So, with a great degree of confidence or little, try and answer it here based upon what your decision makers know or will tell you now. You will at least determine what you need to ask each decision maker.

**Worksheet 5.5.a Monitoring Question will be answered by XYZ”**

*Do your best at this point to answer how each monitoring question per Assessment Type will be answered. Phase 2 and 3 will help you finalize this task. If completed Worksheet 4.3.a, can cut/paste or use it.*

| <b>Assessment Type: ____</b>              | <b>Reason (Step 3):</b>     | <b>Use (Step 3):</b> |
|---|-----------------------------|----------------------|
| <b>Monitoring question: ____ of ____:</b> | <b>Will be answered by:</b> |                      |
| <b>Monitoring question: ____ of ____:</b> | <b>Will be answered by:</b> |                      |
| <b>Monitoring question: ____ of ____:</b> | <b>Will be answered by:</b> |                      |
| <b>Monitoring question: ____ of ____:</b> | <b>Will be answered by:</b> |                      |
| <b>Monitoring question: ____ of ____:</b> | <b>Will be answered by:</b> |                      |
| <b>Monitoring question: ____ of ____:</b> | <b>Will be answered by:</b> |                      |

**For Sheet 5.6            Define any Ambiguous terms associated with each Assessment Type monitoring reason and question.**

Define any ambiguous terms in your monitoring question. Ambiguous terms are any terms that can have multiple meanings depending upon the reader. It is not so important they your definition is right or wrong but that terms are defined. Readers can decide for themselves if that meaning matches their needs.

In your monitoring questions, outputs, outcomes or watershed vision. Define any ambiguous terms. Ambiguous terms are any terms that can have multiple meanings depending upon the reader. These include:

- ✓ Clean
- ✓ Healthy
- ✓ Unimpaired
- ✓ Remediated



**For Sheet 5.9**      **Place Products in your** *Watershed Monitoring and Assessment Plan*

- Refined data use(r), list of selected decision makers and the decision they will make, to target for each Monitoring Question
- The best cut at specific information needs of the selected decision makers you choose to target, including Data Quality Objectives, this will be summarized in the next step and be used as the foundation for Phase 2 , 3 and 4.
- First cut at every monitoring question answer, "I know monitoring question A will be answered when XYZ..".
- Ambiguous terminology defined

**Worksheet 5.9.a** Place Products in your *Watershed Monitoring and Assessment Plan*.

**If you completed any Steps this Worksheet is cumulative, use that document. If you have not you complete that aspect that is highlighted for your plan documentation.** *\*Italics mean a sub plan that might be attached or live somewhere else, location of document and contact is what would go in the plan.*

- I. People Design, Phase 1
  - A. Shared Watershed Vision and Desired Outcomes (Step 1)
    1. Logic Model of Desired Outcomes/Results and activities/target audiences to employ to achieve outcomes
  - B. Keepers of the M & A Plan (Step 1)
  - C. Watershed Boundary (Step 2)
  - D. Water bodies of Interest (Step 2)
  - E. Scope Inventory Master List\* (Step 2)
    1. Physical Inventory \* (Step 2)
    2. People Inventory\* (Step 2)
    3. Information Inventory\* (Step 2)
      - a. Existing Monitoring Efforts (Step 2)
      - b. Existing Data Sources (Step 2)
    4. Inventory Action Plan\* (Step 2)
  - F. Assessment Type(s) List – Monitoring Reason + Use (Step 3)
    1. → Monitoring Question(s) (Step 4)
    2. → Targeted Decision Maker(s) (Step 5)
      - a. → Information Needs (Step 5)
    3. Information Blue Print – Data Pathway Fact Sheet Per Monitoring Question\* (Step 6)
- II. Technical Design, Phase 2
  - A. What (Indicators, Benchmarks, etc.) and why? (Step 7)
  - B. When and why? (Step 8)
  - C. Where and why? (Step 9)
  - D. W(how) will meet data quality objectives? (Step 10)
    1. Data quality objectives (Step 5 and 10)

2. Quality Assurance and Control Measures (Quality Assurance and Control Plan)\* (Step 10)
- E. Data Management for Raw Data (Data Management Plan Part 1)\* (Step 11)

### III. Information Design, Phase 3

- A. Data Summary and Analyses (Step 12)
  1. Starting Point (Step 12)
  2. Changes (Later)
- B. Data Interpretation, Conclusions, Recommendations
  1. Starting Point (Step 13)
  2. Changes (Later)
- C. Communication and Delivery
  1. Starting Point (Step 14)
  2. Changes (Later)
- D. Management Plans to Generate Information (Data Management Plan Part 2)\* (Step 15)

### IV. Evaluation Design, Phase 4

- A. Who Will Do What? (Step 16)
  1. Task Identification Matrix (Step 16)
  2. Communication Structure and Tools (Step 16)
- B. Evaluation Plans (Step 17)
  1. Evaluation Plans for M & A Components (Step 17)
  2. Evaluation Plans for M & A Implementation (Step 17)
  3. Evaluation of inter/intra M & A Activities (Step 17)
- C. Documentation and Communication (Step 18)
  1. M & A Plan (**this document**, updated Sub documents) (Step 18)
  2. Communication and Peer Review Plan (Step 18)
  3. Action Plan\* (Step 17)

**For Sheet 5.10**      **Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan).**

**Worksheet 5.10.a      Final *Action Plan* Part 1, Summary:**

*If you have completed each Step, or for those you have, you have a cumulated list of gaps and needs related to that Step. Use that same worksheet/document. If you did not complete each Step, look at what each Step is supposed to accomplish and record what your gaps and needs are related to that topic. The goals are to get the gaps and needs in one place to evaluate and prioritize.*

|  |
|--|
| <b>Phase 1 Step 1: (completed in Step 1)</b>   |
| <b>Phase 1 Step 2: (completed in Step 2)</b>   |
| <b>Phase 1 Step 3: (completed in Step 3)</b>   |
| <b>Phase 1 Step 4: (completed in Step 4)</b>   |
| <b>Phase 1 Step 5:</b>   |
| <b>Phase 2, 3 and 4 Steps: Will add Action and Needs as complete each Step and at the end prioritize</b> |

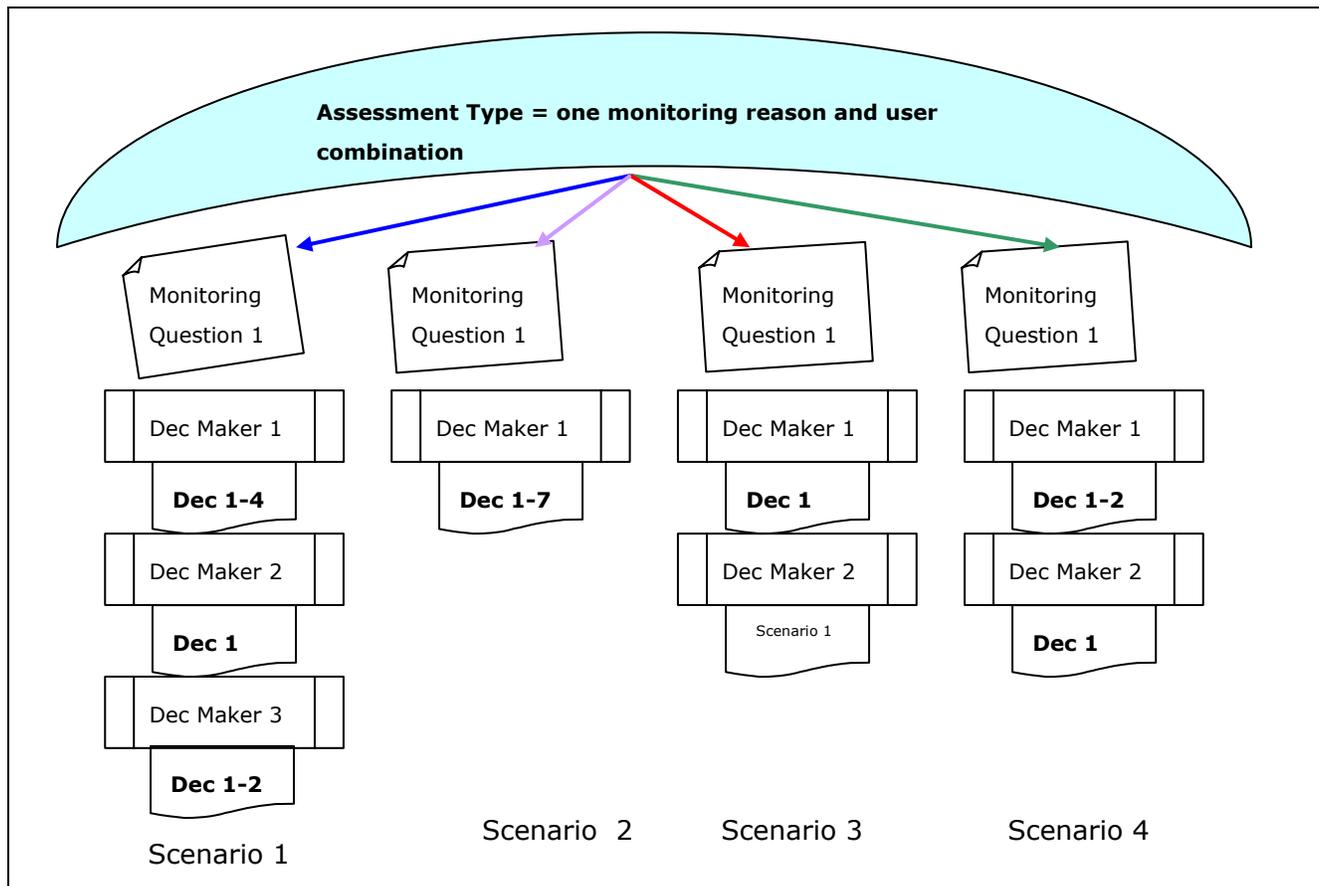
Background and Content

**Identify all Decision Makers and Decisions they make for each Monitoring Question**

*Who is a Decision Maker?*

A decision maker is whoever will be making the decision. Often there will be multiple decision makers for each monitoring question. If you have multiple data uses, you probably have multiple data users and thus multiple decision makers. The continuum of decision makers includes you, your organization or membership, a group/stakeholders, your board, community, a neighborhood, a classroom of students, to non regulatory entities and regulatory entities. A decision maker is anyone who will be making a decision with the data you generate regardless of how formal or informal the decision process is.

With each Assessment Type, you have one specific combination of a monitoring reason and data use or user. The data user is refined into a decision maker. You might have multiple decision makers who will all make the same one decision. You might have multiple decision makers who make a similar decision and their ultimate action will be different. You might have one decision maker that makes several decisions. The idea is to figure this out so you can identify specific decision makers information needs. The figure below illustrates four possible scenarios from one Assessment Type.



It may require research and contact time to identify a decision maker and or their information needs. It is entirely possible and likely that a decision maker may not know their decision process or information needs. They may never have thought about it or defined it, even though it exists. They may be defensive or feel vulnerable about sharing these items. Be prepared, be persistent, be gentle and kind. Ultimately you may not really need them to make a difference. If you are the decision maker or your decision maker cannot or will not provide the information, you can borrow from other experts and assessments; you can define your starting point. That is what everyone does, from the educator to rigorous compliance enforcer, informally or formally.

Good planning will have you ask what information is needed in great detail so that you can plan and try to get what is needed rather than shooting in the dark. The difficulty in this exercise is not so much deciding who you should target but discovering what they need.

*What if my decision maker is not a scientist?*

It may be more frustrating to define information needs of individuals or user groups that do not have scientific backgrounds. In many cases using the information needs designed via the Clean Water Act and your state regulatory agency may provide a framework, a way of doing or thinking that could provide the basis for you to “begin” to define your information needs to make a credible scientific decision,–even if you have no plans to take your results to the regulatory agency. Often the perception is that these “things” are clearly defined if only I could just get the information, when in fact, they often aren’t. The key lies in identifying the information needs as well as the uncertainty or confidence you may have in the definitions. You may identify those needs by using others, modifying others or developing your own. It is essential they are identified for evaluation of success or failure, accountability, credibility.

*Identify all decision makers for each monitoring question*

Get your list of monitoring questions and how the question will be answered from Step 4. If you could not complete the criteria, or how you will answer each objective, this may help complete that table as well. At the end of this you need to decide for every monitoring question what you will use to answer the question before proceeding.

**The table below provides some examples of decision makers/decisions, purpose and possible indicators or criteria.**

| Monitoring question   | Indicators and Supporting Information  | User/Decision Maker  | Uses/Decisions   |
|---|--|----------------------|--|
| To locate the sources of high bacteria levels and determine whether correction measures work. | Location of each possible source (possible point and non-point: e.g. WWTP or on-site system, haulers, etc.)<br>Gallons per day produced by each source | Local officials      | To set priorities for assistance and correction  |
|   | Number of clean outs of home septic systems  | Group itself         | To assess whether septic system education campaign is working                                    |
|   | Historic and recent bacteria levels at swimming areas  | Group itself         | To establish a baseline to determine trends  |
|   | Current bacteria levels at swimming areas  | Groups itself<br>PCA | To assess current health risk<br>To assess use support status and allocate funds for restoration |

| Monitoring question | Indicators and Supporting Information           | User/Decision Maker  | Uses/Decisions  |
|---------------------|---|----------------------|---|
|                     | Current bacteria levels above and below sources | Local health officer | To post warning signs and bathing areas, if warranted |
|                     |   | Group itself         | To determine the impact of specific sources           |
|                     |   | Local officials      | To set priorities for correction                      |
|                     |   | PCA                  | To set effluent limits                                |

For each Decision Maker/Decision describe how decision made and what information is needed by Decision Maker

For each decision maker/decision, describe how the decision is made and what information they need to make the decision. In the example below, the first cut might look like:

- ➔ Assessment type is X, the data reason is use support, the data use/user is the State CWA 305(b) and 303(d) process
  - ➔ The specific monitoring question is "Does water body ABC meet the recreation standard for fecal coliform?"
    - ➔ Decision maker is State Health Commission, decision they make is water body ABC is or is not attaining recreation use class 1
      - ➔ When/How - Decision made every two year in 303(d) hearing, see process regulation RFP123.
        - ➔ What, where, when, how, QA/QC, DQO's, Information needed to make decision is "...", retrieved from data requirements document.

**Example of 305(b) Information and Data Requirements:**

| Uses (Users)   | Parameters              | Time Period           | Minimum # of values | Methods Required | Certified Lab Needed? | QAPP Required?     | Data Submission: When and In What Form? |
|--|-------------------------|-----------------------|---------------------|------------------|-----------------------|--------------------|---|
| To assess use support status for possible restoration (PCA - 303d) | Fecal coliform bacteria | Most recent 10 years. | 10                  | SM9222           | Yes                   | Yes if \$ from EPA | Triennial Review 303 d listing process  |

Even if you aren't submitting data to the 305(b) report, the information generated for it, the decision process for it might serve your decision making needs, so use it.

You want it all though, what do they *really* need to make the decision? Ideally the list of information *need* questions to answer would include:

| Information Needs of Decision Maker |   |                       |             |
|-------------------------------------|---|-----------------------|-------------|
| Monitoring question:                |   |                       |             |
| Decision Maker ___ of ___:          |   |                       |             |
| ?                                   | Item  | Design Element        | Your Answer |
| What                                | Key processes, natural/political?   | Technical             |             |
| What                                | Key Indicators needed, in what media?   | Technical             |             |
| What                                | Where do they need it from (key locations, political, historical, etc.)?          | Technical             |             |
| What                                | Benchmarks and references they use, criteria, metrics, indexes, statistics, etc.? | Technical Information |             |
| What                                | What frequency/duration (length of record) does information need to be?           | Technical             |             |
| What                                | How "good" does it have to be (peer reviewed, certain methods, etc.) be?          | Technical             |             |
| What                                | Methods are they using, need you to use, field/lab                                | Technical             |             |
| What                                | What acceptance/performance criteria do they use?                                 | Technical             |             |
| What                                | Information needs to be included besides data or information, meta data?          | People                |             |

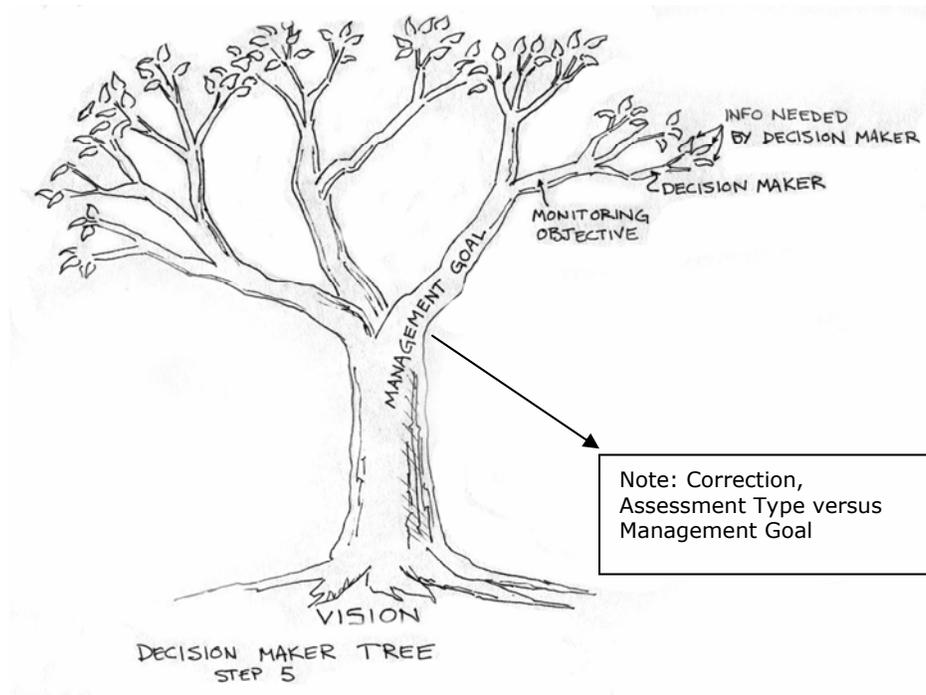
|             |   |             |  |
|-------------|---|-------------|--|
| <b>What</b> | Will you deliver, raw data, analyzed, interpreted, conclusions, recommendations, where will you exit? | Information |  |
| <b>How</b>  | Do they need you to analyze, interpret, conclude or recommend   | Information |  |
| <b>How</b>  | Is the decision made? Process, formal, legal, rigorous, opportunities                                 | People      |  |
| <b>How</b>  | Do they need the information, format?   | Information |  |
| <b>How</b>  | Will it be delivered, mail, meeting, hearing, orally, etc.?   | Information |  |
| <b>When</b> | Is the decision made?   | People      |  |
| <b>When</b> | Do they need the data or information at what frequency?   | Information |  |
| <b>Who</b>  | Will deliver the data and then evaluate if decision was made and role of information?                 | Information |  |

You would have a sheet like above for every decision maker per monitoring question.

If completed this for every decision maker/monitoring question and every monitoring question per Assessment Type, and every Assessment Type per outcome, the hierarchy looks like this:

- ➔ Watershed Vision /Outcomes-results
  - ➔ Assessment Type X per outcomes
    - ➔ Monitoring question 1-5 (questions per Assessment Type)
      - ➔ Decision maker & decision per monitoring question 1-5
        - ➔ Info need for decision per decision maker, list above

Depending upon how this is documented, the results can look like a “tree” of sorts where the watershed vision and associated outcome/results are the roots, each assessment type (an activity with a target audience/decision maker) is the trunk or major branch from the trunk, each monitoring question for each assessment type is a smaller series of branches off that one trunk arm, each tiny branch off each monitoring question is the list of decision makers and each leaf is the information they need to make the decision. If this was completed for every assessment type, monitoring questions, associated decision makers/decision and information needs, you would have a large full foliage tree.



| <b>Outcome: Water quality is good enough for drinking, growing crops and fishing, or to protect and enhance water quality in Blue River</b> |   |  |                                |
|---|---|--|--------------------------------|
| <b>Assessment Type: A1</b>  |   |  |                                |
| <b>Monitoring question</b>  | <b>Decision Maker</b>                   | <b>Decision make</b>   | <b>Info needs (list above)</b> |
| 1. Establish current water quality conditions   | 1.1 Myself                              | 1.1.1 Quality is good/bad, trend is up/down                      | Temperature, pH, fish, etc.    |
|   | 1.2 city official, established educator | 1..2.1 Quality is "?" so must request permits for dischargers    | same as for me, plus ????      |
|   | 1.3 local health department             | 1.3.1 Create regulation for point source permits for dischargers | ????                           |
| 2. establish trends in water quality from historic data and for future  | 2.1                                     |  |                                |

You will probably need to conduct some research and establish relationships in order to complete this decision making tree. If hear yourself say, "I don't know" in response to who is the decision maker, what decision would they make, how do they make it or what information do they need to make it, even if the decision maker is you, you will need to research, ask questions and establish relationships to find out. You will need to make a decision with a degree of confidence.

Once this decision tree is complete it will illustrate several key items, some of which include: the scientific, political and social processes interacting, their overlap and points of influence, what and who you know, where structure and function may be breaking down if decision makers are in one organization for example, where your possible points of influence are, and how your monitoring data will be inexplicably connected to a decision maker, creating an information link or an action link. This is referred to as the Information Blueprint that makes your monitoring design operate like an information system (Step 6).

The information from this step provides foundation and information to design monitoring, analyses and reporting activities for a defined purpose, use/decision maker, decision by incorporating and identifying the information needs now. These decision trees helps identify, define and clarify what it is you are measuring, why and how it needs to be information.

*Tips*

This decision tree can get cumbersome and overwhelming. If you have multiple data reasons focus on one at a time. You begin to see overlap. The value in this exercise is to identify the range of decision makers you could target versus who you can or want to target, if you cannot target everyone. You may discover several things:

- You may redirect your effort entirely
- You may discover you don't have the resources, expertise, etc. to produce all the information for a particular decision maker
- You may discover partners, common ground with decision makers

- You may discover who you need to build relationships and why

If you have multiple assessment types, start with one and work it through to this point.

If you have a large list of monitoring questions, prioritize them and work a few of them to this point.

If you have a large list of decision makers, prioritize them and work the top few through to this point.

*Using existing data, yours or others*

If you conducted a people and information inventory you may have discovered data you could use or entities collecting data you could use. You need to put that data through a quality check list to make sure it is compatible on all fronts with your Assessment Type, see *Step 2 Resource Guide* as well as *California Watershed Assessment Manual Draft*, [http://cwam.ucdavis.edu/Manual\\_chapters.htm](http://cwam.ucdavis.edu/Manual_chapters.htm), Chapter 4, Collecting and Organizing Existing Data.

### **Introducing Data Quality Objectives (DQO's)**

DQO's help significantly with planning and evaluation of effective monitoring. Data quality objectives are defined acceptance and performance criteria developed for the collection, evaluation and use of specific environmental data. Acceptance and performance criteria are qualitative and quantitative statements that *clarify study objectives, define the appropriate type of data and specify tolerable levels of potential decision errors* that will be used as the basis for establishing the quality and quantity of data needed to support the decisions. Acceptance and performance criteria are based upon the ultimate use of the data and required quality assurance and quality control practices required to support the decision.

When environmental data are to be used to select between two opposing conditions, development of DQO's are recommended. In this case the data quality objectives define the performance criteria. If data are to be used for stressor identification, estimation, research or any other objective that does not select between two opposite criteria, a formal process should be used to define the problem, examine information needs, and determine study boundaries. These become the performance criteria versus the outputs of the DQO process.

One develops DQO's through a DQO process, systematic planning process, based on the scientific method and/or simple systematic planning. The scientific method uses objectivity of approach and criteria for acceptability of results to formulate conclusions:

1. Observe some aspect in the environment
2. Invent a tentative theory or hypothesis consistent with what observe
3. Use hypothesis to make predictions
4. Test hypothesis by planned experiments or the collection of further observations
5. Ask, are there discrepancies between theory and observations?
6. If answer = NO, then draw conclusion theory is true. If answer = YES, then modify theory or hypothesis in light of results or new observations

Systematic planning, which the DQO process is, is based on common sense, graded approach to ensure that the sampling design for data collection will support the decision making process it will travel through with available resources. The seven step DQO process is design for data to be used to test the difference between two or more clearly defined alternatives. The steps are:

1. State the problem (observation why have desired outcome)
2. Identify the decision (monitoring question and how will answer)
3. Identify the inputs to the decision (information needs of the decision maker to make the decision)
4. Define the boundaries of the study (geographic and temporal scope, water bodies of interest, etc.)
5. Develop a decision rule (define statistical parameter (mean, median, etc.), specify action level, develop logic for action)
6. Specify tolerable limits on decision error (Set acceptable limits for decision errors relative to consequences (health effects, costs, impairment, etc.). Decision error is the error you want to avoid. It is the error where the data mislead the decision maker into the 'wrong' decision or selecting the wrong response. In statistical tests, decision errors are labeled as false rejections/acceptance-choosing the wrong choice due to wrong data or baseline. In non statistical tests, decision errors can be identified.
7. Optimize the design for obtaining data (select resource effective sample and analyses plan that meets performance criteria)

DQO's are different from quality assurance and quality control measures. QA and QC methods and measures define how "good" the data needs to be to make the decision. DQO's define, in context with the problem, monitoring questions and desired decision, the characteristics and boundaries of how the decision will be made.

If your assessment type does not include testing the difference between two or more clearly defined alternatives, you don't need DQO's as described above. You do need to determine performance criteria to the appropriate degree. Your performance criteria systematic planning steps might be the same, minus the statistical significance:

1. State the problem (observation why have desired outcome)
2. Identify the decision (monitoring question and how will answer)
3. Identify the inputs to the decision (information needs of the decision maker to make the decision)
4. Define the boundaries of the study (geographic and temporal scope, water bodies of interest, etc.)
5. Develop a decision rule [define statistical parameter (mean, median, etc.), specify action level, develop logic for action – *or other criteria that will help determine if the monitoring question is answered or not, not necessarily looking for statistical significance*]

6. Specify tolerable limits on decision error (Set acceptable limits for decision errors relative to consequences (health effects, costs, impairment, etc.))
7. Optimize the design for obtaining data (select resource effective sample and analyses plan that meets performance criteria)

This information from EPA Guidance for the Data Quality Objectives Process EPA QA/G-4, EPA/600/R-96/056. See an example of each step for both DQO and non DQO performance criteria in *Step 5 Resource Guide*.

For each monitoring question or question, identify how you will know when that question is answered.

The goal is to be able to document the statement, “Monitoring question X will be answered by XYZ”, with XYZ defined. The goal is to understand what information you want in order to plan adequately to generate the information you need.

*What Information Do You Need?*

Below is a table with some examples. This is where others work, similar and sometimes not similar can be of assistance. What variables, metrics, benchmarks, criteria, etc. will tell you if your monitoring question is answered? The list of potential decision makers or data users might also be of assistance. How are they answering this monitoring question with their data? How is another group answering this question or a related question? What might academia know, what do your instincts tell you? It is plausible you cannot answer this question yet.

There is a general belief that professionals know what they are doing with a certain conviction. While this is true, much of what they know or what they learn is through the same trial and error you have to be willing to risk. Much of this work is forging new turf. It is okay to define XYZ based on what you know today. The limitations of XYZ will carry through analyses, reporting and evaluation. It is individuals and entities that do their best to define something, try it, learn, modify, and improve the next round. You are part of science which is dynamic.

**If you don’t have any idea, this is an area we will do some research on. Don’t give up, identify this as a need in your action plan, we will resolve this in the next step.**

| Monitoring Goal   | Indicators and Supporting Information   |
|---|---|
| To locate the sources of high bacteria levels and determine whether correction measures work. | Location of each possible source (possible point and non-point: e.g. WWTP or on-site system, haulers, etc.) |
|   | Gallons per day produced by each source   |
|   | Number of clean outs of home septic systems   |
|   | Historic and recent bacteria levels at swimming areas   |
|   | Current bacteria levels at swimming areas   |
|   | Current bacteria levels above and below sources   |

For every monitoring question, try to complete the statement, “Monitoring question X will be answered by XYZ”, with XYZ defined. The goal is to understand what information you want in order to plan adequately to generate the information you need.

Define or redefine XYZ, for each monitoring question “My Monitoring Question A will be answered by XYZ.”

In the above example that could look like: “The monitoring question is met when I see monthly data from sites A, B and C for fecal coliform, 2 year period and all values are under the state criteria of “SSSS”. You might have varying answers to this per decision maker.

If you need to for every monitoring question, complete the statement “monitoring question ABC will be answered by XYZ.” Define XYZ based on information generated from this step. In addition, adjust monitoring questions based upon DQO’s if you discovered any.

If your DM can answer these or know these, planning Phase 2 and 3 will be much easier. If you cannot answer how you will answer your monitoring question, ask, research and find a starting point. Phase 2 and 3 will help you figure out a starting point. Basically you will fall under these scenarios:

- ◆ You know or, you don’t know but decision maker does and can tell you. Take the information and use it to plan Phase 2 and 3.
- ◆ You don’t know and decision maker can’t/won’t tell, go forward with Phase 2 and 3 to identify starting point.
- ◆ You don’t know and decision maker doesn’t know but pretty good idea that Assessment Type X will answer your question, go forward with Phase 2 and 3 to identify starting point.
- ◆ You don’t know and can’t get help, need to identify an assessment type and approach decision makers, experts, etc. to help define starting point. Breaking trail.

### **Define any Ambiguous Terms**

In your monitoring questions, outputs, outcomes or watershed vision. Define any ambiguous terms. This is the time to clarify definitions with your decision makers. Ambiguous terms are any terms that can have multiple meanings depending upon the reader. These include:

- ◆ Clean
- ◆ Healthy
- ◆ Unimpaired

It is not so important that your definition is right or wrong, good or bad, more that it is defined and meaningful and documented. Others can decide for themselves if your definition is aligned with theirs or not.

### **Prioritize and Select which decision makers you will target.**

The last activity is to select which decision makers you will target. It is appropriate to conduct another relevance check to ensure alignment with values, mission, vision and programs. You may discover that you don’t want to or can’t target someone or entity for a variety of reasons. This helps you determine that before you expend resources or determine what you need to do in order to be effective.

You will want to check in again, this time with organizational values, mission and capacity. You need to select which decision makers you will commit to targeting. They become your targeted data users.

When done have the foundation to design Phase 2 Data Acquisition, scale and study area, Phase 3 Information and Utilization and Phase 4 Evaluation and Effectiveness.

Case Study 1:

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Case Study 2:

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## References

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*Guidance for the Data Quality Objectives Process EPA QA/G-4*, USEPA, Office of Environmental Information, Washington, D.C. EPA/600/R-96/056, August 2000, [www.epa.gov](http://www.epa.gov) (on-line).

On the EPA Quality System – Systematic Planning Website, for more information on systematic planning you will find frequently asked questions (FAQ's):

- What is systematic planning?

Systematic planning is simply using a methodical, or ordered, approach to planning, to plan projects and link goals (outcomes), cost and schedule and the quality criteria with final activities/audiences (outputs).

- Why use systematic planning approach?
- What are key elements of systematic planning?

The elements are abbreviated elements of what we have in these 18 steps, primarily Phase 1, that requires you define and determine who will use the data for what purposes and what information is needed (quantity and quality), in order to determine the W's to gather the data and then how you will turn data into information Phase 3).

- Do I need systematic planning for my project?
- How do I systematically plan my project?
- What are some examples of systematic planning processes?
- How do I document my systematic planning?

On the EPA Quality System – Systematic Planning Website, for projects **planning to collect new data**, <http://www.epa.gov/quality> :

- *Guidance for Quality Assurance Project Plans (G-5)*, PDF (401KB), identifies elements to consider when designing new data collection
- *Quick Guide to Selection Sample Design*
- *Guidance on Choosing a Sampling Design For Environmental Data Collection (G-5S)*, PDF (1046KB) contains guidance on applying standard statistical sampling designs (such as random sampling) and more advanced sampling designs (such as ranked set sampling, adaptive cluster sampling) to environmental applications.
- *Using Professional Judgment to Develop a Sampling Design*
- *Software for estimating Sample Size and location*, Decision Error Feasibility Trials (DEFT) Software (G-4D) User's Guide, PDF (275KB) and software (436KB) is PC-based software for determining the feasibility of data quality objectives defined using the Data Quality Objective Process
- *Visual Sample Plan (VSP)*, is a non EPA product disclaimer that is a simple, defensible tool for defining an optimal, technically defensible sampling scheme for site characterization (a data reason).
- Self Completed Training courses offered for

- *Assessing Quality Systems*
- *Detecting Improper Laboratory Practices*
- *Introduction to Data Quality Assessment*
- *Introduction to Data Quality Objectives*
- *Introduction to Quality Assurance Project Plans,*
- *Introduction to Data Quality Indicators.*
- *Introduction to Data Quality Management Plans*
- *Interpreting Monitoring Data*
- *Interpreting Multivariate Analyses*

On the EPA Quality System – Systematic Planning Website, for projects planning to use existing data, <http://www.epa.gov/quality>

- *Data quality assessment* – before existing data is used, it should be assessed against its intended use
- *Checklist for quality concerns* (PDF 148KB), draft checklist and list of resources for evaluating secondary data
- *EPA’s Science Policy Council Assessment Factors*, general assessment factors for evaluating the quality of scientific and technical information
- Software – for links to free software for performing data quality assessments, see *quality-related resources-software* (on website).
- Website systematic planning, resources for planning new data collection, Resources for planning projects that use existing data (quality check list for using others data-**Step 2 Resource Guide**) Resources for planning an information product.

*California Watershed Assessment Manual Draft*, [http://cwam.ucdavis.edu/Manual\\_chapters.htm](http://cwam.ucdavis.edu/Manual_chapters.htm), Chapter 4, for tips on collecting and organizing existing data.

U.S. EPA, On-line Training Courses on Water Quality Assurance and Quality Control Activities, <http://www.epa.gov/quality/trcourse.html>, including:

- ◆ Assessing Quality Systems
- ◆ Detecting improper Laboratory Practices
- ◆ Introduction to Data Quality Assessment
- ◆ Introduction to Data Quality Indicators
- ◆ Introduction to Data Quality Objectives
- ◆ Introduction to Quality Assurance Project Plans

## Resources

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Contents in Phase 1, Step 5 Resource Guide:

1. Limit Definitions Related to Data Quality Objectives.
2. USGS Policy on Significant Digits and Rounding
3. ASTM Policy on Significant Digits and Rounding
4. Excerpt from *Guidance for the Data Quality Objectives Process EPA QA/G-4*, on Data Quality Objectives what are they, what is the “Process” and why it can help you
5. Elements of Systematic Planning, EPA
6. Quality check list for using others data, 1-7 assessments. (See last Reference listed above as well).

## RESOURCE GUIDE

### ***Step 5: Target Decision Makers and Information Needs (Refinement of Data Use)***

#### **Contents**

1. Limit Definitions Related to Data Quality Objectives.
2. USGS Policy on Significant Digits and Rounding.
3. ASTM Policy on Significant Digits and Rounding.
4. Excerpt from *Guidance for the Data Quality Objectives Process EPA QA/G-4*, on Data Quality Objectives: what are they, what is the “Process”, and why it can help you.
5. Elements of Systematic planning.
6. Quality check list for using others data, 1-7 assessment points.

### **Limit Definitions Related to Data Quality Objectives:**

(primarily from *Guidance for the Data Quality Objectives Process EPA QA/G-4*, USEPA, Office of Environmental Information, Washington, D.C. EPA/600/R-96/056, August 2000, [www.epa.gov](http://www.epa.gov) (on-line))

1. **Data Quality Objectives:** qualitative and quantitative statements derived from the DQO Process that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.
2. **Data Quality Assessment:** a statistical and scientific evaluation of the data set to determine the validity and performance of the data collection design and statistical test, and to determine the adequacy of the data set for its intended use.
3. **Quality Control:** the overall system of technical activities that measure the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer, operational techniques and activities that are used to fulfill requirements for quality.
4. **Quality Assurance:** an integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the customer.
5. **Acceptance criteria:** specific limits placed on characteristics of an item, process, or service defined in requirements documents.
6. **Action level:** the numerical value that causes a decision maker to choose one of the alternative actions (e.g. compliance or non compliance). It may be a regulatory threshold standard, such as a maximum contaminant level for drinking water, a risk-based concentration level, a technology limitation, or a reference-based standard. Note that the action level defined here is specified during the *planning* phase of a data collection activity, it is not calculated from the sampling data.
7. **Decision errors:** the error that occurs when the data mislead the site manager into choosing the wrong response action, in the sense that a different response action would have been chosen if the site manager had access to unlimited “perfect data” or absolute truth. In statistical tests, decision errors are labeled as false rejection or false acceptance depending on the concerns of the decision maker and baseline conditions chosen.
8. **Limits on decision errors:** the acceptable decision error rates established by a decision maker. Economic, health, ecological, political and social consequences should be considered when setting limits on decision errors.
9. **Detection Limit:** a measure of the capability of an analytical method of distinguish samples that do not contain a specific analyte from sample that contain

low concentrations of the analyte; the lowest possible level among the target analyte that can be determined to be different from zero by a single measurement at a stated level of probability (to be able to say this value is no different than zero, or greater than zero with confidence). DL's are analyte-matrix specific and may be laboratory dependent.

10. **Reporting Limit:** What you actually report and see others report as a result, considering what is the appropriate significant digit and rounding procedures. It is a combination of the detection limit and practical quantitation limit / minimum detection limit, appropriate significant digit and rounding procedure. Often inappropriately called detection limit. Significant digit implies you will not report a larger digit that the analytical method can detect. For example, if your pH meter can read 7.01, it really is not "measuring" that 100ths digit. The appropriate significant figure to report is 10ths, or 7.1. This leads then to rounding decisions if your method produces more digits than you significantly report. See the next two attachments for more information.
11. **Practical Quantitation Limit (PQL):** Often confused with detection limit, the lowest level an analyte could be measured above detection limit that a decision maker determines an analytical method can reliably and consistently produce. It is analyte and laboratory specific and is usually 2-5 times the detection limit. It is also called the minimum detection limit (MDL). Often inappropriately called detection limit.
12. **Bias:** the systematic or persistent distortion of a measurement process that causes errors in one direction (e.g. the result is the expected sample measurement is different from the sample's true value).
13. **Measurement error:** the difference between the true or actual state and that which is reported from measurements. Also known as measurement variability.
14. **Null hypothesis:** a tentative assumption to be proven true or false, such as treatment X is working, cadmium concentrations at Y are exceeding standard X on a monthly average, or X aquatic community has reduced species composition below Y. When hypothesis testing is applied to site assessment decisions, the data are used to choose between a presumed baseline condition of the environment and an alternative condition. The alternative condition is accepted only when there is overwhelming proof that the baseline conditions false. This is often called the alternative hypothesis in statistical tests. The hypothesis could be fecal coliform concentrations are *above* ABC Threshold in waterbody Y this month. The alternative hypothesis would be the opposite, that fecal coliform concentrations are *below* ABC Threshold in waterbody Y this month.
15. **Type 1 error:** the statistical term for false rejection decision error or rejecting your hypothesis conclusion and it is really true.

16. **Type 2 error:** the statistical term for false acceptance decision error or accepting your hypothesis conclusion and it is really not true.
17. **Total Study Error:** the sum of all the errors incurred during the process of sample design through data reporting. This is usually conceived as a sum of individual variances at different stages of sample collection and analysis. Also known as total variability.
18. **Natural variability:** the variability that is inherent or natural to the media, objects or people being studied.
19. **Sampling:** the process of obtaining a subset of measurements from a population.
20. **Sample Design:** the design that specifies the final configuration of the environmental monitoring effort to satisfy the DQO's. It includes what types of samples or monitoring information should be collected, where, when, and under what conditions they should be collected, what variables are to be measured, and what quality assurance and quality control components will ensure acceptable sampling error and measurement error to meet the decision error rates specified in the DQO's. The sample design is the principal part of the quality assurance plan.
21. **Sample Design Error:** the error due to observing only a limited number of the total possible values that make up the population being studied (dissolved cadmium in the water column for example). Sampling errors are distinct from those due to imperfect site selection, bias in response, and mistakes in observation, measurement or recording. Also known as field variability.
22. **Estimate:** a characteristic from the sample from which inferences on parameters can be made.
23. **Precision:** a measure of mutual agreement among individual measurements of the sample property, usually under prescribed similar conditions expressed generally in terms of the standard deviation.
24. **Distribution:** 1) the appointment of an environmental contaminant at a point over time, over an area, or within a volume: 2) a probability function (density function, mass function, or distribution function) used to describe a set of observations (statistical sample) or a population from which the observations are generated.
25. **Statistic:** a function of the sample measurements (e.g., the sample mean, sample variance).
26. **Variance:** a measure of the dispersion of a set of values. Small variance indicating a compact set of values; larger variance indicates a set of values that is far more spread out and variable.

27. **Confidence interval**: the numerical interval constructed around a point estimate of a population parameter, combined with a probability statement (the confidence coefficient) linking to the populations' true parameter value. If the same confidence interval construction technique and assumptions are used to calculate future intervals, they will include the unknown population parameter with the same specified probability.
28. **Standard Operating Procedure (SOP)**: a written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps and that is officially approved as the method for performing certain routine or repetitive tasks.

## USGS Policy on Significant Digits and Rounding:

USGS Policy for Storing and Reporting Significant Figures for Chemical Data

In Reply Refer To:  
Mail Stop 412

February 14, 2002

Office of Water Quality Technical Memorandum 2002.11

Subject: Policy for Storing and Reporting Significant Figures for Chemical Data

This memo establishes the policy of the Office of Water Quality (OWQ) for storing and reporting the appropriate number of significant figures for chemical data in the U.S. Geological Survey's National Water Information System (NWIS) and describes the systematic implementation of this policy.

Concepts presented in this memo were developed over the past year by members of the Phoenix Water-Quality User Group, and by staff from OWQ, the Branch of Quality Systems (BQS), and the National Water Quality Laboratory (NWQL).

Questions about the established policy and the concepts presented in this memo should be directed to Pete Rogerson ([rogerson@usgs.gov](mailto:rogerson@usgs.gov)) or Stephen Sorenson ([sorenson@usgs.gov](mailto:sorenson@usgs.gov)) in OWQ.

### Background and Purpose:

All water-quality data have an associated uncertainty resulting from variability in sample collection, preparation, and analysis. This memo addresses only the uncertainties associated with laboratory sample preparation and analysis. Data should be stored in and reported from NWIS at a level of significance that accurately reflects these uncertainties.

Too many digits imply a higher level of precision than is justified by a particular analytical method. Too few digits potentially eliminate real information about the actual measured constituent concentration that may be critical for interpretation. Current guidance (Novak, 1985, and Hansen, 1991) for reporting significant figures in USGS data reports and other publications recommends that when "presenting numerical data, give only those digits that convey actual information. The last digit should represent the uncertainty in the data."

There is no universally recognized means for determining the location of this uncertain digit and the OWQ has not had a defined policy. This memo establishes the practice that will be implemented by the OWQ to derive the significant figures for analytical values by determining the variability of the method using laboratory replicate samples distributed over a range of constituent concentrations. These determinations of variability will then be used to estimate the precision of individual results over the full analytical range of the method.

Policy:

The convention for reporting rounded analytical values in NWIS is to include all digits known with certainty, plus one digit that is uncertain.

The uncertain digit will be called the least significant digit (LSD) in this document. Determination of the LSD will follow the guidance outlined by the American Society for Testing and Materials (1993).

Laboratories will report data to the NWIS database to the least significant digit plus one additional digit (LSD+1). One additional uncertain digit is recommended because there is potentially useful information in this added data that will contribute to the ability to statistically evaluate large data sets.

Standard USGS publication policy is to report all numbers rounded to the LSD. Standard rounding procedures in NWIS will be written to properly round results to the LSD, but additional retrieval options will be available for users to retrieve data at the LSD+1 level for use in statistical and interpretive analyses.

Measurement of variability in analytical methods and the designation of significant figures for each measured constituent is the responsibility of each laboratory providing data to NWIS. The number of significant figures to be reported for a particular laboratory analysis by a particular method will be based on measurement variability for multiple points in the concentration range. The performance of analytical methods will continue to be monitored by the individual laboratories to determine if the initial variability determined for the method is representative of longer-term variability. Each laboratory must define the rationale and operational procedures they will use to report significant figures. A review of these procedures will become part of periodic reviews of each laboratory by the BQS, as implementation of this policy is achieved.

Implementation:

It will take time to implement the substantial changes outlined in this memo. Structural changes and changes in reporting conventions will be required for NWIS and upgrades will need to be made to laboratory software.

The OWQ and BQS will initially pilot this change with the NWQL and the Ocala Water Quality and Research Laboratory (OWQRL). Following successful implementation, the plan will be applied to field water-quality determinations and at other water-quality production laboratories.

Currently the NWIS database does not have the capability to store the necessary information to fully implement this policy, and will not have this capability until the 4\_2 release currently scheduled for FY 2002. The Phoenix Water-Quality User Group, OWQ, and BQS will continue to work with the NWQL and OWQRL to develop and test procedures needed for this new policy. Until this policy is fully implemented, data publication and rounding will continue to be done by the default rounding rules provided through the NWIS parameter code dictionary.

The guidance provided in this memo does not fit all water-quality data that the USGS uses in its investigations. Some procedures, such as radiochemical determinations, isotope analyses, and counts of organisms in biological samples may not allow for the determination of variability or may produce results that are expressed in units of measurement that are not consistent with this policy. The OWQ and others will be working toward more consistent and scientifically defensible ways to determine how to best present and store these types of data as experience is gained with this process. Regardless of how the LSD is determined, it is critical that every data user decide whether the number of significant figures provided is appropriate for the intended use of the data.

References:

American Society for Testing and Materials, 1993, Standard practice for using significant digits in test data to determine conformance to specifications: Section 7.4, Reporting Test Results: Annual Book of ASTM Standards, Volume 14.02, pp. 19-22.

Hansen, W.R., 1991, Suggestions to authors of the reports of the United States Geological Survey, (7th ed.) pp. 119-121.

Novak, C.E., 1985, Preparation of water-resources data reports: U.S. Geological Survey Open File Report 85-480, 331 p.

Stephen K. Sorenson /s/  
Acting Chief, Office of Water Quality

This memorandum does not supersede any other Office of Water Quality Technical Memorandum.

Distribution: All WRD Employees

\*\*\*\*\*

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# Significant Figures & Rounding

Our policy with respect to significant figures and rounding at the IonSource.Com web site.

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## **Introduction:**

The purpose of this web page is to set forth in some manner the method with which we treat numbers at IonSource.Com. We are aware that there are many great significant figure tutorials presented on the internet and we agree that this presentation does not necessarily add anything new to those discussions, for a list of some of these other web pages see the links at the bottom of this page. The sole purpose of this presentation is to describe to the reader how we deal with significant figures and rounding exclusively at IonSource.Com.

Scientists routinely attempt to describe the world with numbers and if you are a mass spectroscopist you had better love numbers because in many instances they are all you have, except perhaps for the occasional flaming turbo. As a good friend once told me, "Every credible scientific study should be reducible to a table filled with meaningful significant numbers."

It is important to establish a policy with which you treat numbers. Some companies go so far as to establish a document called an SOP, standard operating procedure. Then when a regulatory agency comes to call and when they need show them how they derived an assay result without bias, they can point to the SOP and say, "See, we passed this release test by 0.00001 glicks because our SOP tells us to always round up in this situation." The situation you do not want to be in is the one where you barely pass a test because the analyst always rounds up but the regulatory agency finds instances where another analyst, or worse the same analyst, did something else in a different situation. This can lead the agency to the conclusion that you only round up when you need to pass a test.

Even if you are not answerable to a regulatory agency and the world does not rest on your shoulders you will gain respect from your peers by treating numbers with respect and by reporting only significant figures and by rounding properly.

## **What is a significant figure?**

There are two types of significant figures, measured and exact.

## Measured significant figures

As scientists we get a large amount of the figures we report and use in calculation from measured observation. Whether a digit is determined to be significant or not is determined by the capability of the measuring device. In a number derived from a measurement the last significant digit to the right inherently expresses an uncertainty. For example if you are sure that your low resolution quadrupole type mass spectrometer can deliver accurate measurements to a tenth of a mass unit then you would be justified in reporting masses to a tenth of a mass unit. For example if one measured a mass of 110.1 u this number would contain four significant figures with the last digit expressing the uncertainty. The uncertainty would be plus or minus 0.05 u. Even if the instrument is capable of reporting 10 digits passed the decimal point one should only report the significant digits. Errors can arise in calculations if insignificant figures are used in a calculation. If a number resulting from a measurement is used in a calculation that involves multiplication or division all significant figures should be carried through the calculation and then the result should be rounded at the end of the calculation to reflect the term used in the calculation with the fewest significant figures. For example  $10.4 \times 5.0$  should be reported as 52 and not 52.0. If the calculation involves addition and subtraction a different rule applies, one should preserve common decimal places of the numbers involved. For example if two numbers obtained from a measurement are used in an addition,  $10.1 + 1000.234$  the reported number should be 1010.3. Notice that 10.1 has 3 significant figures and 1000.234 has 7 significant figures and the result of the addition has 5 significant figures.

### General rules for determining the number of significant figures in a number:

- A) All non-zero numbers are significant.
- B) All zeros between significant numbers are significant, for example the number 1002 has 4 significant figures.
- C) A zero after the decimal point is significant when bounded by significant figures to the left, for example the number 1002.0 has 5 significant figures.
- D) Zeros to the left of a significant figure and not bounded to the left by another significant figure are not significant. For example the number 0.01 only has one significant figure.
- E) Numbers ending with zero(s) written without a decimal place possess an inherent ambiguity. To remove the ambiguity, write the number in scientific notation. For example the number 1600000 is ambiguous as to the number of significant figures it contains, the same number written  $1.600 \times 10^6$  obviously has four significant figures.

### Several Notes:

- 1) It is important to know the accuracy and precision of the measuring device one is using and it is important to report only those digits that have significance. To reiterate, your

electrospray mass spectrometer may be able to spit out 10 numbers past the decimal place but you should only use the digits that have significance in reporting or in a calculation.

2) It is generally accepted that the uncertainty is plus or minus 0.5 units at the level of the uncertainty, for example the "true value" for the number 0.003 can be described as being bounded by the numbers 0.0025 and 0.0035. It is important to note that in some instances scientists will sometimes want to express an uncertainty that exceeds 1 at the level of the uncertainty and this should be noted explicitly in the following fashion,  $0.003 \pm 0.002$

## Exact Numbers

Exact values are those that are counted without ambiguity, for example the number of mass spectrometers in the lab is exactly three, or the number of cars in the parking lot is exactly four. These numbers carry no ambiguity and can be considered to have an infinite number of significant figures. When using these numbers in a calculation the restriction on reporting is borne by the measured number if any.

## Rounding significant figures

(now it gets personal)

As far as I can tell rounding of significant figures carries a certain degree of controversy and people will argue with you based on what they were taught at some point in their education. For example I learned from my "Biostatistics" course in college that when rounding a number that is followed by a 5, for example 1.1150, one should round up to the even number, 1.12 or not round up if the number was already even. The explanation that the professor gave was that even numbers are easier to deal with in a calculation, which now seems to me like an odd reason. More recently I have been told from statisticians that I respect that this procedure removes the rounding bias. They explain that without bias half of the time the number is rounded up, to me this makes a lot of sense, after all as scientists we want to be as unbiased as humanly possible. Others always round up in this situation regardless of whether the number is even or odd. Our position on this subject is we don't care what you do, but you should establish your own policy and follow it absolutely consistently, but of course just so you will understand, the method we have adopted is correct (a little joke). Another painful detail that can cause controversy is that if the number following the 5 is not a zero, for example 1.1151, the number should be rounded up. This is the policy that we follow. Again set your own policy or if you are working with a larger group follow that policy. Be consistent.

### **Rounding policies that everyone agrees with:**

If you are rounding a number to a certain degree of significant digits if the number following that degree is less than five the last significant figure is not rounded up, if it is greater than 5 it is rounded up.

Examples:

A) 10.5660 rounded to four significant figures is 10.57

B) 10.5640 rounded to four significant figures is 10.56

## Conclusion:

We agree that we have not addressed every controversy on this subject but we hope that you understand how we deal with numbers at IonSource.Com. For a quality easy to follow tutorial on rounding and significant figures visit [Dr. Stephan Morgan](#) at the University of South Carolina. If you need to find a consultant to teach a course on statistics at your company we suggest [Statistical Designs](#), they also have several tutorials on-line. The people at Statistical Desings teach statistics and experimental design for the American Chemical Society. For an interesting paper on significant figures and rounding visit [Dr.Christopher Mulliss](#) at his web site.

Other significant figure and rounding sites we have found:

[http://www.chem.ufl.edu/~chm2040/Notes/Chapter\\_1/figures.html#nist](http://www.chem.ufl.edu/~chm2040/Notes/Chapter_1/figures.html#nist)

<http://www.chem.vt.edu/chem-ed/scidex.html>

<http://www.angelfire.com/oh/cmulliss/index.html>

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Last updated:

## SIGNIFICANT DIGITS

The number of significant digits in an answer to a calculation will depend on the number of significant digits in the given data, as discussed in the rules below. *Approximate* calculations (order-of-magnitude estimates) always result in answers with only one or two significant digits.

### When are Digits Significant?

Non-zero digits are always significant. Thus, 22 has two significant digits, and 22.3 has three significant digits.

With zeroes, the situation is more complicated:

- a. Zeroes placed before other digits are not significant; 0.046 has two significant digits.
- b. Zeroes placed between other digits are always significant; 4009 kg has four significant digits.
- c. Zeroes placed after other digits but behind a decimal point are significant; 7.90 has three significant digits.
- d. Zeroes at the end of a number are significant only if they are behind a decimal point as in (c). Otherwise, it is impossible to tell if they are significant. For example, in the number 8200, it is not clear if the zeroes are significant or not. The number of significant digits in 8200 is at least two, but could be three or four. To avoid uncertainty, use scientific notation to place significant zeroes behind a decimal point:

$8.200 \times 10^3$  has four significant digits

$8.20 \times 10^3$  has three significant digits

$8.2 \times 10^3$  has two significant digits

### Significant Digits in Multiplication, Division, Trig. functions, etc.

In a calculation involving multiplication, division, trigonometric functions, etc., the number of significant digits in an answer should equal the least number of significant digits in any one of the numbers being multiplied, divided etc.

Thus in evaluating  $\sin(kx)$ , where  $k = 0.097 \text{ m}^{-1}$  (two significant digits) and  $x = 4.73 \text{ m}$  (three significant digits), the answer should have two significant digits.

Note that whole numbers have essentially an unlimited number of significant digits. As an example, if a hair dryer uses 1.2 kW of power, then 2 identical hairdryers use 2.4 kW:

$$1.2 \text{ kW} \{2 \text{ sig. dig.}\} \times 2 \{\text{unlimited sig. dig.}\} = 2.4 \text{ kW} \{2 \text{ sig. dig.}\}$$

## Significant Digits in Addition and Subtraction

When quantities are being added or subtracted, the number of *decimal places* (not significant digits) in the answer should be the same as the least number of decimal places in any of the numbers being added or subtracted.

Example:

5.67 J (two decimal places)

1.1 J (one decimal place)

0.9378 J (four decimal place)

7.7 J (one decimal place)

## Keep One Extra Digit in Intermediate Answers

When doing multi-step calculations, *keep at least one more significant digit in intermediate results* than needed in your final answer.

For instance, if a final answer requires two significant digits, then carry at least three significant digits in calculations. If you round-off all your intermediate answers to only two digits, you are discarding the information contained in the third digit, and as a result the *second* digit in your final answer might be incorrect. (This phenomenon is known as "round-off error.")

## The Two Greatest Sins Regarding Significant Digits

1. Writing more digits in an answer (intermediate or final) than justified by the number of digits in the data.
2. Rounding-off, say, to two digits in an intermediate answer, and then writing three digits in the final answer.

Try these Exercises:

1.  $e^{kt} = ?$ , where  $k = 0.0189 \text{ yr}^{-1}$ , and  $t = 25 \text{ yr}$ .
2.  $ab/c = ?$ , where  $a = 483 \text{ J}$ ,  $b = 73.67 \text{ J}$ , and  $c = 15.67$
3.  $x + y + z = ?$ , where  $x = 48.1$ ,  $y = 77$ , and  $z = 65.789$
4.  $m - n - p = ?$ , where  $m = 25.6$ ,  $n = 21.1$ , and  $p = 2.43$

### Answers

## Least significant digit

Sometimes abbreviated as LSD, the least significant digit is the lowest digit in a number, located at the far right of a string.

## ASTM Significant Figure and Rounding Methods.

Designation: E 29 – 02<sup>ε1</sup>

An American National Standard

### Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>1</sup>

This standard is issued under the fixed designation E 29; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

<sup>ε1</sup> NOTE—Editorial changes were made to Footnote 4, Table 1, and Paragraph 7.4 in November 2003.

#### 1. Scope

1.1 This practice is intended to assist the various technical committees in the use of uniform methods of indicating the number of digits which are to be considered significant in specification limits, for example, specified maximum values and specified minimum values. Its aim is to outline methods which should aid in clarifying the intended meaning of specification limits with which observed values or calculated test results are compared in determining conformance with specifications.

1.2 This practice is intended to be used in determining conformance with specifications when the applicable ASTM specifications or standards make direct reference to this practice.

1.3 Reference to this practice is valid only when a choice of method has been indicated, that is, either *absolute method or rounding method*.

#### 2. Referenced Documents

##### 2.1 ASTM Standards:

- E 456 Terminology Relating to Quality and Statistics<sup>2</sup>
- SI 10 Standard for Use of the International System of Units (SI) (the Modernized Metric System)<sup>3</sup>

#### 3. Terminology

3.1 *significant digit, n*—any of the figures 0 through 9, excepting leading zeros and some trailing zeros, which is used with its place value to denote a numerical quantity to some desired approximation.

3.1.1 The digit zero may either indicate a specific value or indicate place only. Zeros leading the first nonzero digit of a number indicate order of magnitude only and are not significant digits. For example, the number 0.0034 has two significant

digits. Zeros trailing the last nonzero digit for numbers represented with a decimal point are significant digits. For example, the numbers 1270. and 32.00 each have four significant digits. The significance of trailing zeros for numbers represented without use of a decimal point can only be identified from knowledge of the source of the value. For example, a modulus strength, stated as 140 000 Pa, may have as few as two or as many as six significant digits.

3.1.2 To eliminate ambiguity, the exponential notation may be used. Thus,  $1.40 \times 10^5$  indicates that the modulus is reported to the nearest  $0.01 \times 10^5$  or 1000 Pa.

3.1.3 Use of appropriate SI prefixes is recommended for metric units to reduce the need for trailing zeros of uncertain significance. Thus, 140 kPa and 0.140 MPa each indicate that the modulus is reported to the nearest 1 kPa or 1000 Pa, while 140 kPa may again have two or three significant digits.

#### 4. Significance and Use

4.1 This practice describes two commonly accepted methods of rounding data, identified as the Absolute Method and the Rounding Method. In the applications of this practice to a specific material or materials it is essential to specify which method is intended to apply. In the absence of such specification, reference to this practice, which expresses no preference as to which method should apply, would be meaningless. The choice of method is arbitrary depending upon the current practice of the particular branch of industry or technology concerned, and should therefore be specified in the prime publication.

4.1.1 The unqualified statement of a numerical limit, such as “2.50 in. max,” cannot, in view of different established practices and customs, be regarded as carrying a definite operational meaning concerning the number of digits to be retained in an observed or a calculated value for purposes of determining conformance with specifications.

4.1.2 *Absolute Method*—In some fields, specification limits of 2.5 in. max, 2.50 in. max, and 2.500 in. max are all taken to imply the same absolute limit of exactly two and a half inches

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee E11 on Quality and Statistics and is the direct responsibility of Subcommittee E11.30 on Data Analysis. Current edition approved May 10, 2002. Published July 2002. Originally published as E 29 – 40. Last previous edition E 29 – 93 (1999).

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 14.04.



and for purposes of determining conformance with specifications, an observed value or a calculated value is to be compared directly with the specified limit. Thus, any deviation, however small, outside the specification limit signifies nonconformance with the specifications. This will be referred to as the *absolute method*, which is discussed in 5.

4.1.3 *Rounding Method*—In other fields, specification limits of 2.5 in. max, 2.50 in. max, 2.500 in. max are taken to imply that, for the purposes of determining conformance with specifications, an observed value or a calculated value should be rounded to the nearest 0.1 in., 0.01 in., 0.001 in., respectively, and then compared with the specification limit. This will be referred to as the *rounding method*, which is discussed in 6.

4.2 Section 7 of this practice gives guidelines for use in recording, calculating, and reporting the final result for test data.

**5. Absolute Method**

5.1 *Where Applicable*—The absolute method applies where it is the intent that all digits in an observed value or a calculated value are to be considered significant for purposes of determining conformance with specifications. Under these conditions, the specified limits are referred to as absolute limits.

5.2 *How Applied*—With the absolute method, an observed value or a calculated value is not to be rounded, but is to be compared directly with the specified limiting value. Conformance or nonconformance with the specification is based on this comparison.

5.3 *How Expressed*—This intent may be expressed in the standard in one of the following forms:

5.3.1 If the absolute method is to apply to all specified limits in the standard, this may be indicated by including the following sentence in the standard:

For purposes of determining conformance with these specifications, all specified limits in this standard are absolute limits, as defined in ASTM Practice E 29, for Using Significant Digits in Test Data to Determine Conformance with Specifications.

5.3.2 If the absolute method is to apply to all specified limits of some general type in the standard (such as dimensional tolerance limits), this may be indicated by including the following sentence in the standard:

For purposes of determining conformance with these specifications, all specified (dimensional tolerance) limits are absolute limits, as defined in ASTM Practice E 29, Using Significant Digits in Test Data to Determine Conformance with Specifications.

5.3.3 If the absolute method is to apply to all specified limits given in a table, this may be indicated by including a footnote with the table as follows:

| Capacity<br>mL | Volumetric Tolerance <sup>A</sup><br>± mL |
|----------------|---|
| 10             | 0.02                                      |
| 25             | 0.03                                      |
| 50             | 0.05                                      |
| 100            | 0.10                                      |

<sup>A</sup> Tolerance limits specified are absolute limits as defined in ASTM Practice E 29, for Using Significant Digits in Test Data to Determine Conformance with Specifications.

**6. Rounding Method**

6.1 *Where Applicable*—The rounding method applies where it is the intent that a limited number of digits in an observed value or a calculated value are to be considered significant for purposes of determining conformance with specifications.

6.2 *How Applied*—With the rounding method, an observed value or a calculated value should be rounded by the procedure prescribed in 4.2 to the nearest unit in the designated place of figures stated in the standard, as, for example, “to the nearest kPa,” “to the nearest 10 ohms,” “to the nearest 0.1 percent,” etc. The rounded value should then be compared with the specified limit, and conformance or nonconformance with the specification based on this comparison.

6.3 *How Expressed*—This intent may be expressed in the standard in one of the following forms:

6.3.1 If the rounding method is to apply to all specified limits in the standard, and if all digits expressed in the specification limit are to be considered significant, this may be indicated by including the following statement in the standard:

The following applies to all specified limits in this standard: For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded “to the nearest unit” in the last right-hand digit used in expressing the specification limit, in accordance with the rounding method of ASTM Practice E 29, for Using Significant Digits in Test Data to Determine Conformance with Specifications.

6.3.2 If the rounding method is to apply only to the specified limits for certain selected requirements, this may be indicated by including the following statement in the standard:

The following applies to specified limits for requirements on (tensile strength), (elongation), and (...) given in ..., (applicable section number and title) and (...) of this standard: For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded to the nearest 1kPa for (tensile strength), to the nearest (1 percent) for (elongation), and to the nearest (...) for (...) in accordance with the rounding-off method of ASTM Practice E 29 Using Significant Digits in Test Data to Determine Conformance with Specifications.

6.3.3 If the rounding method is to apply to all specified limits in a table, this may be indicated by a note in the manner shown in the following examples:

6.3.3.1 *Example 1*—Same significant digits for all items:

|   | Chemical Composition,<br>% mass |           |
|---|---------------------------------|-----------|
| Copper  | 4.5                             | ± 0.5     |
| Iron  | 1.0                             | max       |
| Silicon   | 2.5                             | ± 0.5     |
| Other constituents (magnesium + zinc + manganese) | 0.5                             | max       |
| Aluminum  |                                 | remainder |

NOTE 1—For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded to the nearest 0.1 percent, in accordance with the rounding method of ASTM Practice E 29, for Using Significant Digits in Test Data to Determine Conformance with Specifications.

6.3.3.2 *Example 2*—Significant digits not the same for all items; similar requirements:

|           | Chemical Composition, % mass |      |
|-----------|------------------------------|------|
|           | min                          | max  |
| Nickel    | 57                           | ...  |
| Chromium  | 14                           | 18   |
| Manganese | ...                          | 3    |
| Silicon   | ...                          | 0.40 |
| Carbon    | ...                          | 0.25 |
| Sulfur    | ...                          | 0.03 |

Iron remainder

NOTE 2—For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded “to the nearest unit” in the last right-hand significant digit used in expressing the limiting value, in accordance with the rounding method of ASTM Practice E 29, Using Significant Digits in Test Data to Determine Conformance with Specifications.

6.3.3.3 Example 3—Significant digits not the same for all items; dissimilar requirements:

|                            | Tensile Requirements |
|----------------------------|----------------------|
| Tensile strength, psi      | 60 000 to 72 000     |
| Yield point, min, psi      | 33 000               |
| Elongation in 2 in., min % | 22                   |

NOTE 3—For purposes of determination of conformance with these specifications, an observed value or a calculated value shall be rounded off to the nearest 1000 psi for tensile strength and yield point and to the nearest 1 percent for elongation, in accordance with the rounding method of ASTM Practice E 29 for Using Significant Digits in Test Data to Determine Conformance with Specifications.

6.4 Rounding Procedure—The actual rounding procedure<sup>4</sup> shall be as follows:

6.4.1 When the digit next beyond the last place to be retained is less than 5, retain unchanged the digit in the last place retained.

6.4.2 When the digit next beyond the last place to be retained is greater than 5, increase by 1 the digit in the last place retained.

6.4.3 When the digit next beyond the last place to be retained is 5, and there are no digits beyond this 5, or only zeros, increase by 1 the digit in the last place retained if it is odd, leave the digit unchanged if it is even. Increase by 1 the digit in the last place retained, if there are digits beyond this 5.

6.4.4 This rounding procedure may be restated simply as follows: When rounding a number to one having a specified number of significant digits, choose that which is nearest. If two choices are possible, as when the digits dropped are exactly a 5 or a 5 followed only by zeros, choose that ending in an even digit. Table 1 gives examples of applying this rounding-off procedure.

6.5 The rounded value should be obtained in one step by direct rounding of the most precise value available and not in two or more successive roundings. For example: 89 490 rounded to the nearest 1 000 is at once 89 000; it would be incorrect to round first to the nearest 100, giving 89 500 and then to the nearest 1 000, giving 90 000.

6.6 Special Case, Rounding to the Nearest 50, 5, 0.5, 0.05, etc.—If in special cases it is desired to specify rounding to the nearest 50, 5, 0.5, 0.05, etc., this may be done by so indicating in the standard. In order to round to the nearest 50, 5, 0.5, 0.05, etc., double the observed or calculated value, round off to the nearest 100, 10, 1.0, 0.10, etc., in accordance with the procedure in 6.4, and divide by 2. For example, in rounding 6 025 to the nearest 50, 6 025 is doubled giving 12 050 which becomes 12 000 when rounded to the nearest 100 (6.4.3). When 12 000 is divided by 2, the resulting number, 6 000, is

<sup>4</sup> The rounding procedure given in this practice is the same as the one given in the ASTM Manual 7 on Presentation of Data and Control Chart Analysis.

TABLE 1 Examples<sup>a</sup> of Rounding

| Specified Limit                                | Observed Value or Calculated Value | To Be Rounded to Nearest | Rounded Value to be Used for Purposes of Determining Conformance | Conforms with Specified Limit |
|--|------------------------------------|--------------------------|--|-------------------------------|
| Yield point, 36 000 psi, min                   | 35 940                             | 100 psi                  | 35 900   | no                            |
|  | { 35 950                           | 100 psi                  | 36 000   | yes                           |
|  | 35 960                             | 100 psi                  | 36 000   | yes                           |
| Nickel, 57 %, mass, min                        | 56.4                               | 1 %                      | 56   | no                            |
|  | { 56.5                             | 1 %                      | 56   | no                            |
|  | 56.6                               | 1 %                      | 57   | yes                           |
| Water extract conductivity, 40 ms/m, max       | 40.4                               | 1 ms/m                   | 40   | yes                           |
|  | { 40.5                             | 1 ms/m                   | 40   | yes                           |
|  | 40.6                               | 1 ms/m                   | 41   | no                            |
| Sodium bicarbonate, 0.5 %, max, dry mass basis | 0.54                               | 0.1 %                    | 0.5  | yes                           |
|  | { 0.55                             | 0.1 %                    | 0.6  | no                            |
|  | 0.56                               | 0.1 %                    | 0.6  | no                            |

<sup>a</sup>These examples are meant to illustrate rounding rules and do not necessarily reflect the usual number of digits associated with these test methods.

the rounded value of 6 025. In rounding 6 075 to the nearest 50, 6 075 is doubled giving 12 150 which becomes 12 200 when rounded to the nearest 100 (6.4.3). When 12 200 is divided by 2, the resulting number, 6 100, is the rounded value of 6 075.

### 7. Guidelines for Retaining Significant Figures in Calculation and Reporting of Test Results

7.1 General Discussion—Rounding test results avoids a misleading impression of precision while preventing loss of information due to coarse resolution. Any approach to retention of significant digits of necessity involves some loss of information; therefore, the level of rounding should be carefully selected considering both planned and potential uses for the data. The number of significant digits must, first, be adequate for comparison against specification limits (see 6.2). The following guidelines are intended to preserve the data for statistical summaries. For certain purposes, such as where calculations involve differences of measurements close in magnitude, and for some statistical calculations, such as paired t-tests, autocorrelations, and nonparametric tests, reporting data to a greater number of significant digits may be advisable.

7.2 Recording Test Data—When recording direct measurements, as in reading marks on a buret, ruler, or dial, all digits known exactly, plus one digit which may be uncertain due to estimation, should be recorded. For example, if a buret is graduated in units of 0.1 mL, then an observation would be recorded as 9.76 mL where it is observed between 9.7 and 9.8 marks on the buret, and estimated about six tenths of the way between those marks. When the measuring device has a vernier scale, the last digit recorded is the one from the vernier.

7.2.1 The number of significant digits given by a digital display or printout from an instrument should be greater than or equal to those given by the rule for reporting test results in 7.4 below.

7.3 Calculation of Test Result from Test Data—When calculating a test result from test data, avoid rounding of intermediate quantities. As far as is practicable with the calculating device or form used, carry out calculations with the test data exactly and round only the final result.

7.4 Reporting Test Results—A suggested rule relates the significant digits of the test result to the precision of the



measurement expressed as the standard deviation  $\sigma$ . The applicable standard deviation is the repeatability standard deviation (see Terminology E 456). Test results should be rounded to not greater than  $0.5\sigma$  nor less than  $0.05\sigma$ , provided that this value is not greater than the unit specified in the specification (see 6.2). When only an estimate,  $s$ , is available for  $\sigma$ ,  $s$  may be used in place of  $\sigma$  in the preceding sentence.

*Example:* A test result is calculated as 1.45729. The standard deviation of the test method is estimated to be, 0.0052. Round to 1.457 or the nearest 0.001 since this rounding unit, 0.001, is between  $0.05\sigma = 0.00026$  and  $0.5\sigma = 0.0026$ .

**NOTE 4**—A rationale for this rule is derived from representing the standard deviation of a rounded test result by  $\sqrt{\sigma^2 + w^2/12}$  where  $\sigma$  is the standard deviation of the unrounded test result. The quantity  $w/\sqrt{12}$  is the standard deviation of an error uniformly distributed over the range  $w$ . Rounding so that  $w$  is below  $0.5\sigma$  ensures that the standard deviation is increased by at most 1%, while adding more digits would give a misleading impression of precision.

7.4.1 When no estimate of the standard deviation  $\sigma$  is known, then rules for retention of significant digits of computed quantities may be used to derive a number of significant digits to be reported, based on significant digits of test data.

7.4.1.1 The rule when adding or subtracting test data is that the result shall contain no significant digits beyond the place of the last significant digit of any datum.

*Examples:*

- (1)  $11.24 + 9.3 + 6.32 = 26.9$ , since the last significant digit of 9.3 is the first following the decimal place, 26.9 is obtained by rounding the exact sum, 26.86, to this place of digits.
- (2)  $926 - 923.4 = 3$
- (3)  $140\,000 + 91\,460 = 231\,000$  when the first value was recorded to the nearest thousand.

7.4.1.2 The rule when multiplying or dividing is that the result shall contain no more significant digits than the value with the smaller number of significant digits.

*Examples:*

- (1)  $11.38 \times 4.3 = 49$ , since the factor 4.2 has two significant digits
- (2)  $(926 - 923.4)/4.3 = 0.6$  Only one figure is significant since the numerator difference has only one significant digit.

7.4.1.3 The rules for logarithms and exponentials are: Digits of  $\ln(x)$  or  $\log_{10}(x)$  are significant through the  $n$ -th place after the decimal when  $x$  has  $n$  significant digits. The number of significant digits of  $e^x$  or  $10^x$  is equal to the place of the last significant digit in  $x$  after the decimal.

*Examples:*  $\ln(3.46) = 1.241$  to three places after the decimal, since 3.46 has three significant digits.  $10^{3.46} = 2900$  has two significant digits, since 3.46 is given to two places after the decimal.

7.4.1.4 The rule for numbers representing exact counts or mathematical constants is that they are to be treated as having an infinite number of significant digits.

*Examples:*

- (1)  $1 - 0.23/2 = 0.88$  where the numbers 1 and 2 are exact and 0.23 is an approximate quantity.
- (2) A count of 50 pieces times a measured thickness 0.124 mm is  $50 \times 0.124 = 6.20$  mm, having three significant figures.
- (3) A measurement of 1.634 in. to the nearest thousandth, is converted to mm. The result,  $1.634 \times 25.4 = 41.50$  mm, has four significant digits. The conversion constant, 25.4, is exact.

**NOTE 5**—More extensive discussion of dimensional conversion can be found in Standard SI 10.

7.5 *Specification Limits*—When the rounding method is to apply to given specified limits, it is desirable that the significant digits of the specified limits should conform to the precision of the test following the rule of 7.3. That is, the rounding unit for the specification limits should be between 0.05 and 0.5 times the standard deviation of the test.

7.6 *Averages and Standard Deviations*—When reporting the average and standard deviation of replicated measurements or repeated samplings of a material, a suggested rule for most cases is to round the standard deviation to two significant digits and round the average to the same last place of significant digits. When the number of observations is large (more than 15 when the lead digit of the standard deviation is 1, more than 50 with lead digit 2, more than 100 in other cases), an additional digit may be advisable.

7.6.1 Alternative approaches for averages include reporting  $\bar{x}$  to within 0.05 to 0.5 times the standard deviation of the average  $\sigma/\sqrt{n}$ , or applying rules for retaining significant digits to the calculation of  $\bar{x}$ . ASTM Manual 7 provides methods for reporting  $\bar{x}$  and  $s$  for these applications.<sup>4</sup>

**NOTE 6**—A rationale for the suggested rule comes from the uncertainty of a calculated standard deviation  $s$ . The standard deviation of  $s$  based on sampling from a normal distribution with  $n$  observations is approximately  $\sigma/\sqrt{2n}$ . Reporting  $s$  to within 0.05 to 0.5 of this value, following the rule of 7.4, leads to two significant digits for most values of  $\sigma$  when the number of observations  $n$  is 100 or fewer.

*Example:* Analyses on six specimens give values of 3.56, 3.88, 3.95, 4.07, 4.21, and 4.47 for a constituent. The average and standard deviation, unrounded, are  $\bar{x} = 4.0233\dots$  and  $s = 0.3089\dots$ . The suggested rule would report  $\bar{x}$  and  $s$  as 4.02 and 0.31.

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## Data Quality Objectives, what are they, why care about them?,

**excerpted from:** *Guidance for the Data Quality Objectives Process EPA QA/G-4*, USEPA, Office of Environmental Information, Washington, D.C. EPA/600/R-96/056, August 2000, [www.epa.gov](http://www.epa.gov) (on-line).

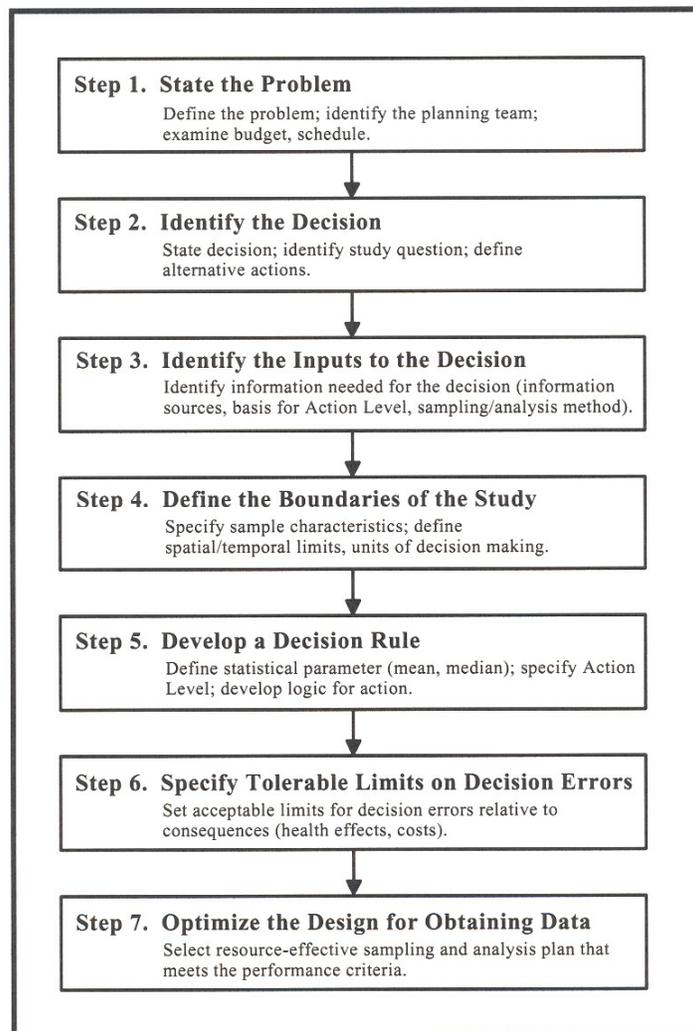
making by selecting between two clear alternative conditions (e.g., compliance/non-compliance with a standard), the Agency’s recommended systematic planning tool is called the DQO Process. Elements of the systematic planning process (from Section 3.3.8 of the EPA Quality Manual) and relationship to the DQO Process are shown in Table 0-1.

**Table 0-1. Elements of the Systematic Planning Process**

| Elements of Systematic Planning Process  | Corresponding Step in the DQO Process  |
|--|--|
| Identifying and involving the project manager/decision maker, and project personnel  | Step 1. Define the problem   |
| Identifying the project schedule, resources, milestones, and requirements  | Step 1. Define the problem   |
| Describing the project goal(s) and objective(s)  | Step 2. Identify the problem   |
| Identifying the type of data needed  | Step 3. Identify information needed for the decision                         |
| Identifying constraints to data collection   | Step 4. Define the boundaries of the study                                   |
| Determining the quality of the data needed   | Step 5. Develop a decision rule<br>Step 6. Specify limits on decision errors |
| Determining the quantity of the data needed  | Step 7. Optimize the design for obtaining data                               |
| Describing how, when, and where the data will be obtained  | Step 7. Optimize the design for obtaining data                               |
| Specifying quality assurance and quality control activities to assess the quality performance criteria                                     | Part B of QA Project Plan  |
| Describing methods for data analysis, evaluation, and assessment against the intended use of the data and the quality performance criteria | Part D of QA Project Plan; DQA Process                                       |

**What are acceptance or performance criteria?** Acceptance or performance criteria are based on the ultimate use of the data to be collected and needed quality assurance (QA) and quality control (QC) practices required to support the decision. In the decision making process, these criteria allow a user to limit decision errors to a fixed level for determining whether or not an Action Level (regulatory or risk-based) has been exceeded.

**What is the DQO Process?** The DQO Process is a seven-step planning approach to develop sampling designs for data collection activities that support decision making. This process uses systematic planning and statistical hypothesis testing to differentiate between two or more clearly defined alternatives. A summary of the seven steps is presented in Figure 0-3.



**Figure 0-3. The Data Quality Objectives Process**

The DQO Process is iterative and allows the planning team to incorporate new information and modify outputs from previous steps as inputs for a subsequent step. Although the principles of systematic planning and the DQO Process are applicable to all scientific studies, the DQO Process is particularly designed to address problems that require making a decision between two clear alternatives. The final outcome of the DQO Process is a design for collecting data (e.g., the number of samples to collect, and when, where, and how to collect samples), together with limits on the probabilities of making decision errors.

**What are DQOs?** DQOs are qualitative and quantitative statements, developed using the DQO Process, that clarify study objectives, define the appropriate type of data, and specify tolerable

levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. DQOs define the performance criteria that limit the probabilities of making decision errors by considering the purpose of collecting the data; defining the appropriate type of data needed; and specifying tolerable probabilities of making decision errors.

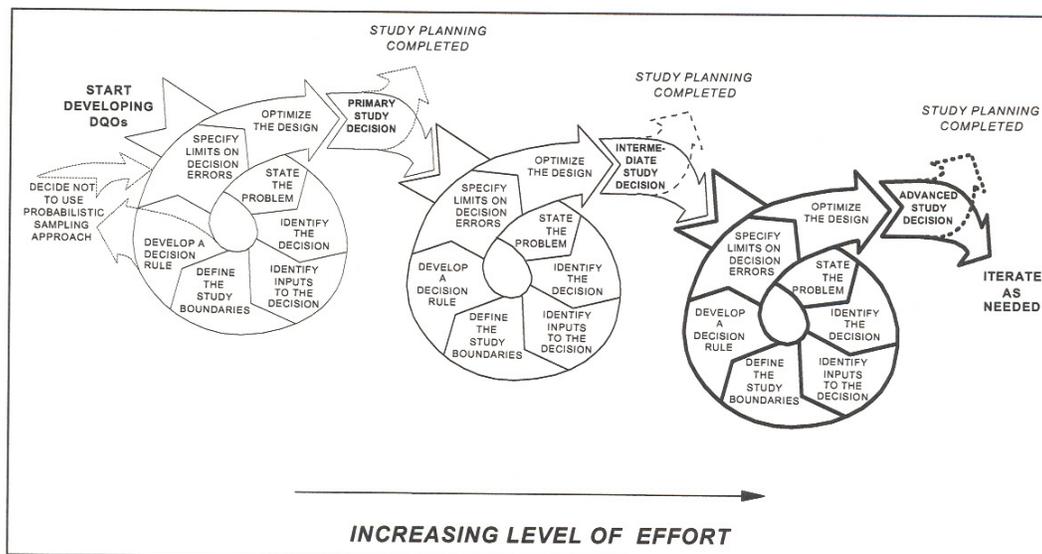
***What projects are covered by the DQO Process?*** The DQO Process may be applied to all programs involving the collection of environmental data used in decision making. The principles used in the DQO Process are also applicable to programs with objectives other than decision making (e.g., estimation and research studies).

***Who should be included in the DQO Process?*** When applying the DQO Process, a planning team of senior program staff, technical experts, managers, data users (usually with some statistical expertise), a quality assurance specialist, regulators, and stakeholders are usually involved. It is important that the key persons participate (or stay informed) throughout the DQO Process so that each individual understands the problem/decision and objectives of the decision-making process. Individuals with specific areas of technical expertise may decide to be involved only in the steps of the DQO Process that require technical input.

***When should the DQO Process be used?*** The DQO Process should be used during the planning stage of any study that requires data collection, *before* the data are collected. As the DQO Process is iterative by nature, steps within the process can be revisited before a final decision is reached. As shown in Figure 0-4, the planning team may choose to revisit selected parts of the DQO Process or to investigate the entire process cyclically.

***Is the DQO Process only applicable to large studies or studies that require multiple decisions?*** The DQO Process applies to any study, regardless of its size. However, the depth and detail of DQO development will depend on the study objectives. The DQO Process is particularly applicable to a study in which multiple decisions must be reached because, by using this planning process, the planning team can clearly separate and delineate data requirements for each problem/decision. For projects that require multiple decisions or answers to more than one question, it is likely that the resolution of one decision will lead to the evaluation of subsequent decisions. In these cases, the DQO Process can be used repeatedly throughout the life cycle of a project. Often, the decisions that are made early in the project will be preliminary in nature; they might require only a limited planning and evaluation effort. As the study nears conclusion and the consequences of making a decision error become more critical, however, the level of effort needed to resolve a decision generally will become greater. Figure 0-4 illustrates this point.

***What are the outputs of the DQO Process?*** The DQO Process leads to the development of acceptance or performance criteria based on the ultimate use of the data to be collected and define the quality required for the decision in terms of acceptance limits on the probabilities of committing a decision error. Each step of the DQO Process defines criteria that will be used to



**Figure 0-4. Repeated Application of the DQO Process throughout the Life Cycle of a Project**

establish the final data collection design. The first five steps of the DQO Process are primarily focused on identifying qualitative criteria, such as:

- the nature of the problem that has initiated the study and a conceptual model of the environmental hazard to be investigated;
- the decisions that need to be made and the order of priority for resolving them;
- the type of data needed (i.e., geographic area, environmental medium, overall timing of data collection, etc.); and
- a decision rule that defines how the data will be used to choose among alternative actions.

The sixth step defines quantitative criteria, expressed as limits on the probability or chance (risk) of making a decision error, that the decision maker can tolerate. The seventh step is used to develop a data collection design based on the criteria developed in the first six steps. In this step the planning team considers the final product of the DQO Process, a data collection design that meets the quantitative and qualitative needs of the study using a specified number of samples that can be accommodated by the budget available. The outputs of the DQO Process are used to develop a QA Project Plan and for performing Data Quality Assessment (Chapter 8).

**What is a data collection design?** A data collection design specifies the number, location, physical quantity, and type of samples that should be collected to satisfy the DQOs. The sampling design designates where, when, and under what conditions samples should be collected; what variables are to be measured; and the QA and QC activities that will ensure that sampling design

and measurement errors are managed sufficiently to meet the tolerable decision error rates specified in the DQOs. These QA and QC activities together with details of the data collection design are documented in the QA Project Plan.

***Can existing data be used in the DQO Process to support your decision making?*** Existing data can be very useful. For example, pilot studies are often performed to provide a preliminary assessment of variability. In these cases, the existing data may provide valuable information to help develop a design for collecting data. It is critical to examine the existing data to ensure that their quality is acceptable for use, or for integration into a new data set. Some considerations include:

- determining if the existing data were collected within approximately the same spatial and temporal boundaries as the new data;
- examining the existing data to determine if this data set includes identical media and analytes;
- examining the performance of the analytical methods for the existing data (accuracy, precision, detection limits) and comparing this to the specifications in Step 3 of the DQO Process for new data to be collected; and
- examining the variability among samples in the existing and new data sets.

Combining existing data and new data can be a very complex operation and you should undertake this with great care. In many cases, statistical expertise is required to evaluate both data sets before they can be combined with confidence.

***Will you always develop statistical/probabilistic sampling designs for data collection if you use the DQO Process?*** No. Although statistical methods for developing the data collection design are strongly encouraged, this guidance recognizes that not every sampling problem can be resolved with probabilistic sampling designs. However, the DQO Process can and should be used as a planning tool for studies even if a statistical data collection design ultimately will not be used. In these cases, the planning team is encouraged to seek expert advice on how to develop a non-statistical data collection design and how to evaluate the results of the data collection. When nonprobabilistic, judgmental, or quota sampling methods are used, be sure to consult with an EPA representative to ensure that program-specific QA requirements are satisfied.

***How should you use this guidance?*** You should use this guidance as a tool to structure the planning activities for collecting environmental data. It should be used to organize meetings, focus the collection of background information, and facilitate communication between a team that includes technical experts, program managers, stakeholders, regulators, and decision makers.

### **0.3 Benefits of Using the DQO Process**

The DQO Process integrates a multidisciplinary team and offers the advantages of using experience and resources of individuals who have different backgrounds, different kinds of

knowledge, and who can collectively focus on achieving a successful project conclusion. During the initial planning stages, the planning team can concentrate on developing requirements for collecting the data and work to reach consensus on the type, quantity, and quality of data needed to support Agency decisions. This interaction results in a clear understanding of the problem and the options available for addressing it, the development of acceptance or performance criteria for decision making, a consensus-based approach to understanding the problem, and data being collected of appropriate quality. Organizations that have used the DQO Process have observed that:

- The structure of the DQO Process provides a convenient way to *document activities and decisions* and to communicate the data collection design to others. This documentation *facilitates rapid review and approval* by regulators and stakeholders.
- The DQO Process enables data users and relevant technical experts to participate collectively in data collection planning and to specify their particular needs prior to data collection. The DQO process fosters *communication among all participants*, one of the central tenets of quality management practices, and directs efforts to *achieving consensus* between decision makers, stakeholders, and regulators.
- The DQO Process helps to focus studies by encouraging data users to *clarify vague objectives* and to limit the number of decisions that will be made. Due to this clarification, *the consequences of decision errors are examined* and correct decisions will be made most frequently when the DQO Process is employed.
- The DQO Process is a planning tool that can *save resources* by making data collection operations more resource-effective. Good planning will streamline the study process and increase the likelihood of efficiently collecting appropriate and useful data.
- The DQO Process provides a method for *defining decision performance requirements* that are appropriate for the intended use of the data. This is done by considering the consequences of decision errors and then placing tolerable limits on the chance that the data will mislead the decision maker into committing a decision error. A statistical sampling design can then be generated to provide the most efficient method for managing decision errors and satisfying the DQOs.

Upon implementing the DQO Process, your environmental programs may be strengthened by:

- focused data requirements and optimized design for data collection,
- use of clearly developed work plans for collecting data in the field,
- uniformly documented data collection, evaluation, and use,
- clearly developed analysis plans,

- sound, comprehensive quality assurance project plans, and
- up-front buy-in by stakeholders to the sampling design and data collection process.

This can lead to:

- rapid review by regulators and other stakeholders,
- defensible results on which to base decisions,
- increased credibility with regulators and stakeholders, and
- a better use of resources.

***Where else can the DQO Process be applied?*** The DQO Process is widely applicable. For example, the Department of Energy Environmental Management program considers the following potential applications for the DQO Process (Grumley, 1994):

- Waste management
  - Characterizing waste, using process knowledge verified by minimal sampling/ analysis data to meet acceptance criteria for treatment, storage, and disposal.
  - Designing optimal monitoring networks for ground water and surface water discharges, and air emissions.
- Environmental restoration
  - Focusing regulatory and public concerns associated with remediation.
  - Identifying target analytes of concern for remedial activities.
  - Determining when remediation has met cleanup levels.
- Facility transition and management
  - Performing characterization assessments, using existing information or collecting new data, to verify facilities for environmental management acceptance.
  - Evaluating alternative end-state conditions and planning facility deactivation in preparation for eventual decontamination and decommissioning.
  - Designing optimized short- and long-term environmental monitoring.
- Decontamination and decommissioning
  - Determining the location and levels of facility contamination.
  - Determining when decontamination and decommissioning is complete.

## Elements of Systematic Planning

EPA's elements of systematic planning are stated in Chapter 3 of the [EPA Manual 5360 - EPA Quality Manual for Environmental Programs](#) (PDF 169KB) and include:

- **Identification and involvement of the project manager, sponsoring organization and responsible official, project personnel, stakeholders, and experts, etc. (e.g., all customers and suppliers).** This element ensures that the study will be designed to address the needs of all vested parties (for example, data users, data generators, data analysts, and other stakeholders). Consulting cross-disciplinary experts familiar with the different technical aspects of the problem ensures that important details of the study are not overlooked or ignored and technical challenges will be addressed appropriately. It is also important to assign responsibilities for the project so that conflicts can be resolved and progress is tracked. For some projects, it may be most effective to create a formal "planning team," while for others, one individual may be responsible for the project and involve other individuals when necessary.
- **Description of the project goals, objectives, and questions and issues to be addressed.** This element ensures that the participants formulate a clear statement of the project's goals and objectives and therefore understand the purpose of the project and expected results. The objectives reflect a general statement of the intent of a project and how that project is linked to addressing the environmental problem (or contributing to the field of science). The project's questions will define what data or information is needed to address the project's goals and objectives. The transition from the project goals, to statement of objectives, to specific and appropriate questions are some of the most important steps in systematic planning.
- **Identification of project schedule, resources (including budget), milestones, and any applicable requirements (e.g. regulatory requirements, contractual requirements).** Identifying the available resources and deadlines at the beginning of a project helps ensure the project is feasible and timely. A clear statement of the project's resources, constraints, and deadlines helps prevent potential issues and/or conflicts by determining practical bounds on the project as early as possible. Regulatory, statutory, contractual and other constraints should be considered that might affect the project schedule.
- **Identification of the type of data needed and how the data will be used to support the project's objectives.** This element focuses on identifying the specific type of data or information needed to complete the project. Types of, sources for, and how to obtain information needed to address the study questions should be listed. Sources may include literature, existing databases, and/or new data collection. By developing a list of the information needed to address the project questions, the project requirements will be clearly defined. In addition, the list may identify other information that will be helpful, or that can be economically collected to facilitate the use of the project results for other purposes.
- **Determination of the quantity of data needed and specification of performance criteria for measuring quality.** This element focuses on establishing criteria to ensure that the information and products generated meet the objectives of the project. These quality specifications are established at both the product level and at the level of components of that product, such as the quality of individual measurements. Examples of product-level criteria include EPA's information quality

guidelines components -- objectivity, utility, integrity, and reproducibility. Examples of component-level criteria are quality criteria for individual measurements (for example, criteria for precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity) and criteria for decisions or estimates [for example, a stated desired confidence that results will fall within a specified window such as Type I and Type II error rates (false rejection and acceptance error rates), uncertainty intervals, etc.] After the information, data, or product is generated, these criteria are used to determine if they met the project's objectives.

- **Description of how and where the data will be obtained (including existing data) and identification of any constraints on data collection.** This element focuses on how to amass the data or information needed for a project by collecting new data, using existing data, citing information from other resources, etc. When collecting new data or information, consider where to collect samples (sampling design), when, how to best acquire physical specimens of an adequate size and dimension (sample support) to represent the variable of interest within the sampling unit, questionnaires and survey instruments, sampling technologies, analytical methods, representativeness, etc. When existing data or information (i.e., from models, databases, literature, etc.) is used, consider sources and methods for assembling it. Also consider how the data will be inspected to ensure compatibility with the project's goals and the handling of information/data either through physical custody of samples or the entering of specific information into a database or spreadsheet.
- **Specification of QA and QC activities to assess the quality performance criteria (e.g., QC samples for both the field and laboratory, audits, technical assessments, performance evaluations etc.).** It is often necessary to plan ahead for QA and QC activities to ensure that a process, item, or service is of the type and quality needed and expected by the customer. QA and QC activities measure the attributes and performance of a process, item, or service against defined standards to verify that it meets the stated requirements. Example of these activities include assessments/audits of field sampling and laboratory activities, QC samples (blanks, duplicates, etc), project reports, and inspections/testing/maintenance of equipment, supplies and consumables, etc.
- **Description of how the acquired data will be analyzed (either in the field or the laboratory), evaluated (i.e., QA review, verification, validation), and assessed against its intended use and the quality performance criteria.** This element focuses on the reviews of both the information (such as verification and validation) and the project (peer reviews, clearance procedures, etc.). It is important to determine up front how data and information will be summarized, displayed, and communicated; how uncertainty in the information will be determined and accounted for in the final product; and how the information will be used to achieve the project's goals.

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Last updated on Thursday, September 2nd, 2004  
URL: <http://www.epa.gov/quality/elements.html>

## USING DATA FROM OTHER SOURCES — A CHECKLIST FOR QUALITY CONCERNS

1. Identify the decision you are making or project objectives (a standard part of project planning or hypothesis testing).
2. Identify the data and information from outside sources proposed for the project/decision support. Note that this may not be obvious. Include data bases, maps and literature, and don't overlook:
  - Information and data used to site or time sampling events (meteorology, geology, etc.)
  - Anecdotal or other information triggering the study
  - Toxicity, exposure, and environmental fate data
  - Models and their output
  - Census data
  - GIS data
3. To avoid investigating information that may not be suitable, determine whether these data have any non-quality constraints affecting their use in the new project/decision support. That is, are there programmatic, legal, or other constraints on the use of the data? Example, is it proprietary or CBI? Does your new project/decision have programmatic constraints requiring only "approved" sources, required peer review or validation of draft data? Obviously, if your proposed data fail these checks, you may not be able to use them, and need not continue down this checklist. If you still plan to use them, you must modify your expectations about the applicability of the project/decision. Check with the program involved. Here are examples:
  - CAA Credible Evidence Revisions (FR 62:36, Feb. 24, 1997)
  - Federal Rule of Evidence 702
4. If not incidental to step 2, determine where the acquired data will be used in the decision making process. That is, will it be used to scope the new project, contribute to data collection in the project, verify the results of the decision, substitute for all or some new data collection, etc.?

**Case 1:** If acquired data will be the basis of comparison for new data, the former's quality should be investigated first, before the new effort begins. This is to both ensure that it is worth the effort of further study and prevent "apples and oranges" results. An example of what can go wrong when this is not done was in the news when Tulane University withdrew a peer reviewed paper published in Science on the effects of mixtures of estrogen. EPA had already mobilized research efforts based on the results. The researcher (and others) found that EPA Quality Staff May 25, 2004 the results could not be replicated and a study design flaw was suspected ("Tulane University Withdraws Paper That Prompted Health Fears", NY Times, AP, 8/21/97). This does not imply that all results must be replicated before use, but a consideration of the decision being made as a result of a single study is warranted.

**Case 2:** If the data are part of scoping or design for more data collection (for example, a pilot project, background historical data, or sample survey), many quality issues can be determined by the resolution of the new effort. If ballpark estimates are good enough, proven reliability of acquired data may be unnecessary. This is especially true if new sampling alone will lead to the decision. Data usability in this case is an individual matter, to be determined by the project manager with statistical help.

**Case 3:** If the acquired data or information are not directly used to compute results, they will still affect the results. An example is the use of existing locational, geological, hydrological, or meteorology data used to locate or time sample collection. The materials and methods involved in producing these data are one consideration, but the quality assurance system implemented to ensure the results were reliable is also important. The source of this information is frequently public domain and used without question. Beware of assuming it is ok especially if it is critical to the new project/decision. How will it affect the outcome?

**Case 4:** If the acquired data will totally substitute for any new data collection efforts, a comprehensive analysis of the past quality assurance controls and hypothetical needs may be required. The effect of the data quality on the decision will directly affect the intensity of effort to determine and document the quality of the data. This sounds like circular reasoning, but the scrutiny of the data will need to match the importance of the decision based upon it, and its contribution to the decision. See the annotated references after item 6. The best guidance for this effort is G-4, if the data quality objectives need to be iteratively applied; R-5, if the QAPP needs to be reconstructed, and G-9, for assessing the data in light of the study objectives.

**Case 5:** A variation of Case 4's substitution for new data collection efforts is a partial substitution of acquired data for new data, for example, in modeling and risk assessment. Some parameters, like environmental concentration data are newly collected, but modeling and other data are EPA Quality Staff May 25, 200 used to infer concentrations in other media, at other times, and in people, animals and plants. Quality concerns can be spread in so many directions, that sorting out the crucial ones seems overwhelming. It has been attempted, however, because the consequences of error are frequently staggering in terms of cost and the health of humans and the environment. See the risk assessment-related references under item 6. 5. Scrutinize data/information for quality concerns pertinent to the intended use. The most straightforward way to approach data quality is to retroactively apply your new data collection standards to the data. For each procedure that was or would have been documented in its QAPP, ask whether it is known and acceptable for the intended use if known. If unknown, first, is it important to the new project/decision, and second, can it be discovered or inferred? This implies the use of the "graded" approach. The ultimate set of quality standards for judging the data are those dictated by the intended use.

For Cases 1, 2, 4, 5: Begin by applying data quality objectives, or discerning those of the existing study (for Case 1). EPA QA/G-9, Box 1.1-1: Example Applying the DQO Process, Retrospectively (1 page).

*Note: Some programs already document decisions based on data from specified outside sources. The decision to use the data is specified by direct comparison with program criteria for their acceptance. The program's decision to use outside sources is presumably made based on their DQOs, documented as such and kept for the public record. The concerns over the data quality are therefore relatively specific given the same source and same type of decision. For example, if public utility data is always the source of emissions inventory data used in setting emissions standards; the program should have DQO-derived acceptance criteria. A valid question is whether all standards can be set with comparable quality if there are fewer data points for one as opposed to many for another. A statistician can help to answer this question for any particular data set. Examples of these programs within EPA include ETV, some air and solid waste rule making and standards, etc. The program QA managers can direct users to these DQOs and data acceptance criteria, and possibly model QAPPs for their use.*

For Case 3: For instances where data/information are used in a project or decision that are not the quantitative result per se, some critical thinking is involved. Qualitative information can not be compared readily to DQOs, but their effect on the outcome should be examined. If it is important to the decision, a justification for using it should be supplied.

For quantitative data derived in other studies yet important to designing, sampling, or modeling results, the quality EPA Quality Staff May 25, 200 should be noted if a “devil’s advocate” approach indicates that problems with its quality could alter project outcomes/decisions.

Many of these concerns are routinely left for study users to consider by simply noting the source of the information and possibly how or why it was used. If a future user of the information has a problem with NOAA’s climate data, they know the study used it. If less familiar sources of information are used, for example a local hydrogeological study for placement of samples, or local reports on presence of certain species key to sampling locations, the reasons for accepting their quality should be sought and noted if it is key to the project/decision.

For investigations of certain quality aspects of acquired information, see the guidance for the other cases. *Example for comparing information to intended use:* If the acquired data represent historical pollutant loads in a water body measured in the spring and the decision to be made must address year-round loading, this must be acknowledged as a factor biasing the decision, if the decision can be made at all.

Whether the data were collected with adequate QA oversight, acceptable methods, by trained samplers, and analyzed with proper holding times, accurate methods with acceptable detection limits may be met. If temporal concerns are not important to the decision, but the absolute concentration will trigger a decision of great importance, a

thorough examination of the QA and QC practices by the data collectors would be essential.

6. Document your analysis plan in a QAPP. If the project also includes some new data collection, list and indicate your intention to investigate the acquired data based on anticipated effects upon the results of that effort. The acquired data investigation results may be a determining step in a decision to proceed with data collection. If the acquired data is substituted for any new data collection efforts, a QAPP is still required.

Remember that the graded approach does apply, and many sections of the QAPP will not apply if there is no new data collection. Depending upon the nature of the decision being made, very little may be required. Turn to QA staff, QA and other guidance for specific assistance in documenting your use of acquired data.

Remember that the original data/information collector(s) may also be the best source of information on the quality system under which it was collected. This information, also called “meta data” may not be published, but it may yet exist. Unfortunately, even if QA requirements exist, it may be difficult to determine if they were followed. For example, even the original sampling and analysis plan or QAPP may not have been followed as written.

7. Execute your analyses and document the outcome appropriately (for the program’s graded approach) relevant to the decision or project. 5 EPA Quality Staff May 25, 200.

### Useful References

The following sources may be useful in the development of acceptance criteria/limitations for the use of data collected for other purposes in order to ensure that it is adequate for the new purpose. This acceptance criterion is documented in a Quality Assurance Project Plan. Note that in some EPA programs, a legislative mandate can determine how the Agency uses data from outside.

Examples include the:

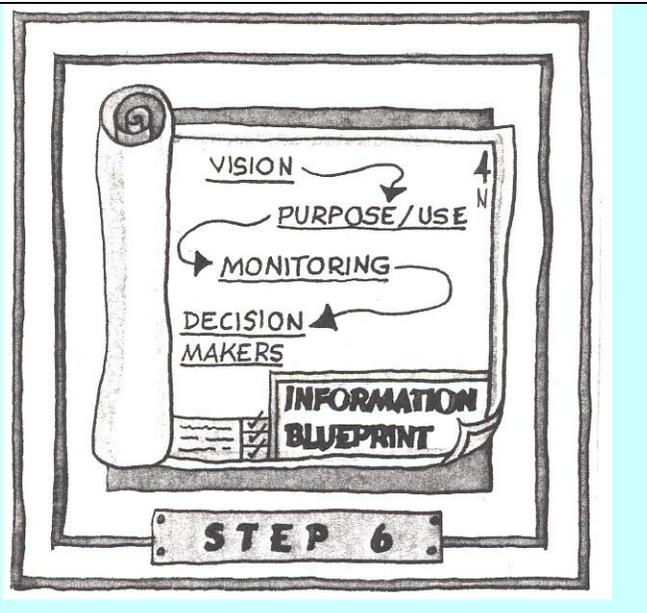
- a. CAA Credible Evidence Revisions (FR 62:36, Feb. 24, 1997) and Federal Rule of Evidence 702. Chalmers, I.; Altman, D.O., eds. *Systematic Reviews* (London, United Kingdom: BMJ Publishing Group 1995)
- b. Ducharme, M.K.; Licklider, B.L.; Matthes, W.A.; Vannatta, R.A., *Conceptual and Analysis Criteria: A Process for Identifying Quality Educational Research* (Des Moines, IA: FINE Foundation 2000)
- c. Fink, Arlene, *Conducting Research Literature Reviews: from paper to the Internet* (Thousand Oaks, CA: Sage Publications, Inc. 1998)
- d. Greenhalgh, T., *How to Read a Paper: The Basics of Evidence Based Medicine* (London, United Kingdom: BMJ Publishing Group 1997)

- e. Exposure Factors Handbook, Volume I of III - General Factors, Update to Exposure Factors Handbook, EPA/600/8-89/043 - May 1989 (EPA/600/P-95/002Ba, August 1996, SAB Review Draft).
- f. Guidance for Data Useability in Risk Assessment (Part A & B), April & May 1992, 9285.7-09A&B, Superfund.
- g. Kollig, H.P. 1988. Criteria for Evaluation the Reliability of Literature Data on Environmental Process Constants. *Toxicological and Environmental Chemistry* 17(4):287-311.
- h. Kollig, H.P. 1990. A Fate constant Data Program. *Toxicological and Environmental Chemistry* 25(2-3):171-179.
- i. Kollig, H.P. and B.E. Kitchens, "Problems Associated with Published Environmental Fate Data". *Toxicological and Environmental Chemistry* 28(2-3):95-103.
- j. Kollig, Heinz. 1993. Environmental Fate Constants for Organic Chemicals Under consideration for EPA's Hazardous Waste Identification Projects. U.S. EPA, Athens, GA, EPA/600/R-93/132.6 EPA Quality Staff May 25, 200
- k. Kollig, H.P. 1995. Environmental Fate Constants for Additional 27 Organic Chemicals Under Consideration for EPA's Hazardous Waste Identification Projects. U.S. EPA, Athens, GA, EPA/600/R-95/039.
- l. Nolan, Melvin, "ORD-NCEA Guidelines for Developing QAPPs for Research Projects Using Existing Peer Reviewed Literature and Meta-data, and Secondary Data", ORD/National Center for Environmental Assessment.
- m. Schumacher, B.A. and Conkling, B. L. User's Guide to the QA/QC Evaluation Scale of Historical Datasets (17p), December 20,1990, unpublished manuscript. First author currently with EPA in Las Vegas.

# PHASE I PEOPLE DESIGN



## Step 6: Summarize with an Information Blue Print - Data Pathway Fact Sheet (per monitoring question)



“The big issue of our time isn’t racism or gender issues or feminism, or even environmentalism, the real problem is our culture. We need to pioneer increasingly potent tools for re-engineering our culture and taking it back from being something that is spoon-fed to us.”

Kalle Lasn

About This Step – This step is designed to accomplish 1 thing:

- ✓ Summarize the data pathway for each *monitoring question* by completing an information blue print that informs the reader the path from how data will be generated, validated, analyzed, interpreted and delivered. The combined monitoring information blueprints, one for each *monitoring question* per Assessment Type, provide a communication tool to document what you are doing and not doing. The information blue print also connects each *monitoring question* back to desired outcomes and watershed vision.

### Why Do This Step?

This blueprint, or an equivalent summary, serves as the **orientation blueprint** necessary to design monitoring. This blueprint illustrates how your monitoring activities will produce results that are filling the information needs of targeted decision makers. It also illustrates the connection between your watershed vision and desired outcomes, associated assumptions and external factors, monitoring activities, objectives and products. It speaks for itself, demonstrating the amount of thought, planning and organization went into the monitoring activities and clearly states what you are doing and why.

This is what makes monitoring and watershed assessment accountable and measurable, even if we don't have all the answers we'd like, all the clarity we need, we make decisions and go forth (all the time), the key is identifying where we started.

### Where are we in the Big Picture Illustration?

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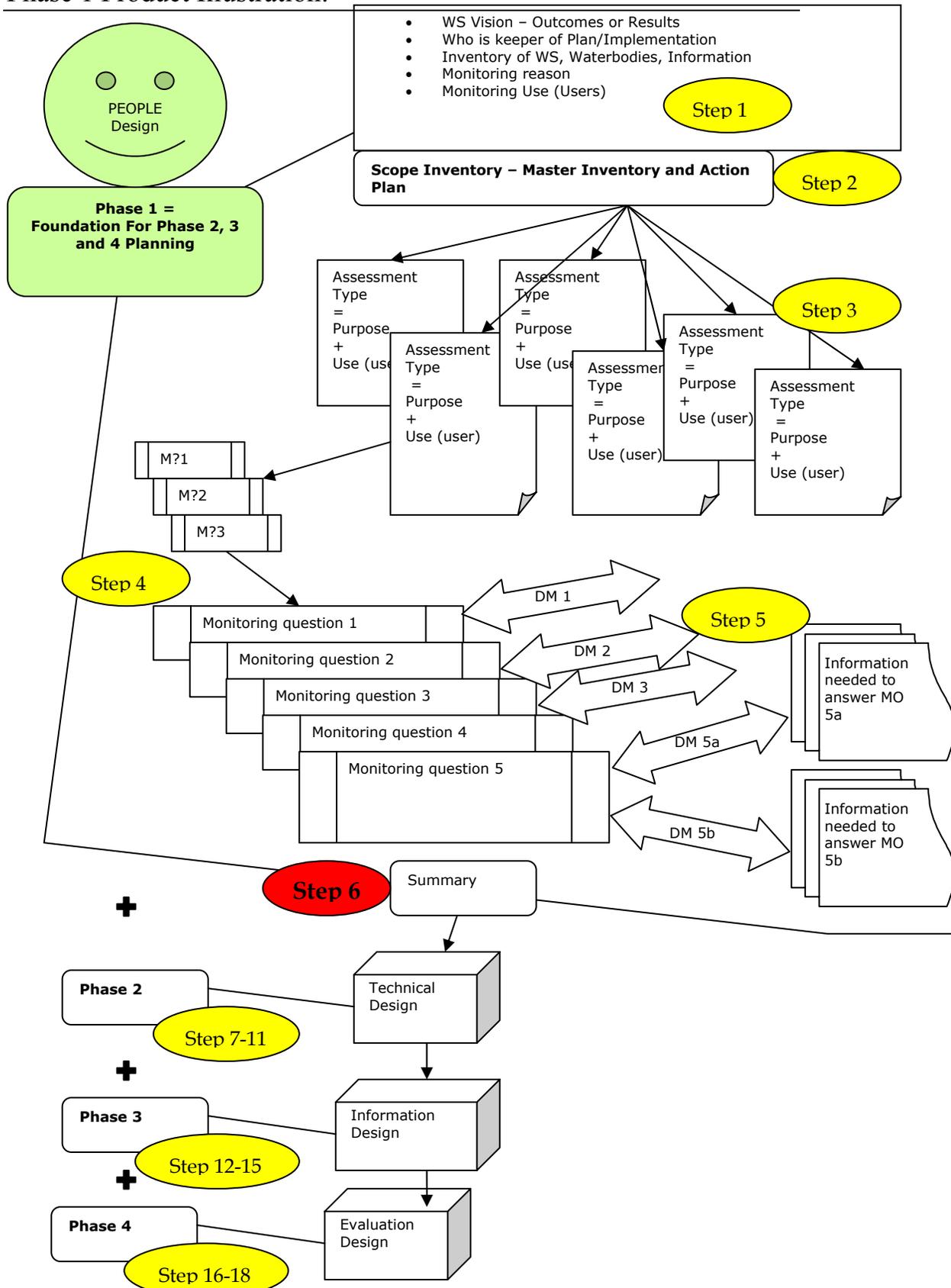
|         |   |
|---------|---|
| Phase 1 | Step 1: Share Watershed Vision and Desired Outcomes (Results)<br>Step 2: Scope Inventory (Physical, People and Information)<br>Step 3: Identify Monitoring Reason(s) and Data Use(s) (Assessment Type)<br>Step 4: Develop Monitoring Questions (Refinement of Monitoring Reason)<br>Step 5: Target Decision Makers and Info Needs (Refinement of Data Use)<br> <b>Step 6: Summarize with Information Blue Print-Data Pathway Fact Sheet)</b> |
| Phase 2 | Step 7: What Will You Monitor?<br>Step 8: When Will You Monitor?<br>Step 9: Where Will You Monitor?<br>Step 10: How Will You Monitor to Meet Data Quality Objectives?<br>Step 11: Management of Raw Data (Data Management Plan Part 1)  |
| Phase 3 | Step 12: Data Summary and Analysis<br>Step 13: Interpretation, Conclusions and Recommendations<br>Step 14: Communicating and Delivery<br>Step 15: Management to Generate Info (Data Management Plan Part 2)   |
| Phase 4 | Step 16: Who Will Do What? Task Identification<br>Step 17: Evaluation of Effectiveness (of Plan and Implementation)<br>Step 18: Documentation and Communication (of M & A Plan)   |

### Product (see Figure Phase 1 Product List):

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- ✓ A mechanism to communicate what you are doing for each Assessment Type and a foundation for designing the nuts and bolts gathering data. We suggest an information blueprint or equivalent. For each set of *monitoring questions* per Assessment Type, an information blueprint summarizing watershed vision, outcomes, related assumptions and external factors, *monitoring reason*, use and objectives, targeted decision makers, their decision, how they make that decision and what information they need to make the decision.

Phase 1 Product Illustration:



## What Should Be Done Before This Step

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Steps 1 through 5 do not need to be completed per say, but the information that is a result of those steps are necessary to identify and define to design the monitoring components of what, when, where and how you will gather data. This information is also necessary to plan how the data will generate information, be managed, analyzed, interpreted, delivered to decision makers and evaluated.

Information generated in Steps 1-5 are the foundation of every monitoring program.

Thus, ideally you need to have identified a watershed vision and desired outcomes with associated assumptions and external factors. Defined combination of *monitoring reasons* and uses, we call Assessment types. For each assessment type a list of monitoring questions the data is to answer and how that question will be answered. For each monitoring question, a list of targeted decision makers, their decision, how they make that decision and what information they need to make the decision. Once you have this, you can summarize the results in any format, we suggests the information blueprint below.

## Basic Tasks

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Basic Tasks are numbered to correlate with the overall 1-18 Steps provided in these guidance modules followed by the basic task sequence step to complete. For example Step 4, basic task 2 would be numbered as Basic Task Step 4.2, Step 3.3 correlates to Step 3, Basic Task 3.



6.1 Identify who will make the decisions about this step and who should be involved in the planning process (they may be different).



6.2 Self Assessment: Identify what decisions have been made and their effectiveness.



6.3 Document the Data Pathway for each monitoring question and use as information blue print communication tool. Data Pathway is the path each data point travels to be validated, turned into information and delivered.



6.4 Relevance Check of each monitoring question, data pathway, cost estimate and effort against organization mission and resources, adjust plans accordingly.

Review and recalibrate the products from Steps 1 (Vision and management goals) and 2 (organizational relevance) if necessary based upon information discovered in this step and answer:

Does the assessment type you chose meet your information needs?

Meet the needs of your targeted decision maker?

Do you have the capacity to carry it out?

Planning is not a linear process only linear on paper. A reminder too that this is the design phase, the blue print, we are making the map - not taking the trip yet, we are planning the house, not building it yet, but we do know where we are going, what we are building and why. At this point, you can also do a draft cost analyses, you may need to answer some more question but could do an estimate at this point.



6.5 Update *Inventory Master List* and *Plan*.



6.6 Place Products in your *Watershed Monitoring and Assessment Plan*.



6.7 Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan).

## Worksheets

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Work sheets are listed below. Not all Basic Tasks have an associated work sheet. To simplify completion of products for each step, the worksheets or broken into small subsets of tasks. This requires moving the results of one task into the next task and will seem redundant, especially if completing worksheets by hand. Worksheets are provided in word here for ease of reproducibility. These are a starting point; we encourage you to customize these and reproduced them in an electronic format, in Excel for example, where it is easy to move information from one area to another by cutting and pasting.

Work Sheets are numbered to correlate with Basic Steps and the overall Steps in these guidance modules. Each consecutive work sheet is lettered a, b, c and so forth, preceded by the Basic Task sequence step, preceded by the Step number. For example, Worksheet Step 4.2.a and Step 4.2.b, correlates to Step 4, Basic Task 2, Worksheet a and Worksheet b. In theory worksheet a needs to be completed before worksheet b.

- Worksheet 6.2.a**      **Self Assessment Step 6 Worksheet and Products to be completed Prior to this Step, Part 1 and Part 2**
- Worksheet 6.3.a**      **Document the Data Pathway for each monitoring question and use as information blue print communication tool. Data Pathway is the path each data point travels to be validated, turned into information and delivered.**
- Worksheet 6.6.a**      **Place Products in your *Watershed Monitoring and Assessment Plan***
- Worksheet 6.7.a**      **Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan)**

## How to do Worksheets

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### **For Sheet 6.2.a Self Assessment Step 6 Worksheet and Products to be completed Prior to this Step, Part 1**

Part 1. Complete the self assessment section of the worksheet to evaluate what you have or what decisions have already been made. This will help you focus on what you need from this step and incorporate valuable existing information or products into this plan.

Part 2. Next, to prepare to complete this step the following, you need to have the following items addressed:

- ✓ Desired set of outcomes or results that the monitoring and assessment activities will be designed to help achieve
- ✓ Identified monitoring and assessment activities, specific combinations of a monitoring reason plus an associated data use; we call this an Assessment Type. You may have multiple Assessment Types.
- ✓ For each Assessment Type, the list of specific monitoring questions the monitoring and assessment will be designed to answer.
- ✓ For each monitoring question, the targeted decision makers, the type of decisions they will make and the information they need to make them (as specific as possible).
- ✓ A minimal scoping inventory that identifies the watershed boundary and water bodies you are focusing on (rivers, lakes or wetlands), physical attributes of water bodies (including status, uses, etc.), relevant cultural or historical aspects, existing data sets or monitoring efforts and others in the watershed who either you want to influence or could help you implement.
- ✓ Technical sample plan including what monitor (indicators, benchmarks, criteria, etc.), where and when monitor, how will meet data quality objectives (methods, how good does the data need to be for decision makers, quality assurance and control measures), and how will manage and verify raw data/information- AT THIS POINT WHAT YOU KNOW, if you don't know it, Phase 2 and 3 help you determine these items.

This is the ideal list, if you do not have any of these, they become a gap or need that should be addressed before any data is collected or analyzed, even if the answers aren't perfect or you don't have a large degree of confidence surrounding them, they should be attempted as the starting point. This is what you are evaluating in this step-your monitoring and assessment plan.

**Worksheet 6.2.a Self Assessment Step 6 Worksheet and Products to be completed Prior to this Step, Part 1.**

*Part 1 Self Assessment of Known Evaluation Products and Processes*

- 1. Determine if you “have” or “don’t have” the item, mark the appropriate box. If you don’t have it and determine you don’t need it, explain why in the comments document. You may not need to know but perhaps your target decision makers, board or membership might want to know.**
- 2. If you have the item “documented”, mark that box. If so, list in the comments where, hard copy, chapter in a document, electronic file name and location, etc. The assumption is you value the ultimate goal to document and communicate your M & A plan, activities and results.**
- 3. If you have the item, assess the use of it, use the scale below or provide your own answer and comments.**

Rating Scale for USE:

- 0=doesn’t exist so use is nil
- 1=don’t know why would need or understand item
- 2=exists, don’t know where it is, if it is used, etc. so use is essentially nil
- 3=exists and use some of time
- 4=exists and use all the time
- 5=wish it existed, would use it lots

- 4. If you have the item, assess the effectiveness of it, just because something exists or is used does not mean it is effective in its use, use the effectiveness scale below or provide your own answer and comments.**

Rating Scale for EFFECTIVENESS, assumes material exists:

- 0=not effective or functional at all
- 1=incomplete (all elements are not there) and some existing parts need revising
- 2=incomplete but what is there is okay
- 3=complete (all elements are there), some parts okay but need revising
- 4=complete and effective

| Item   | Have | Don't Have | DOC | Assessment of Use (Scale 0-5) | Assessment of Value / Effectiveness (Scale 0-4) | Comments |
|--|------|------------|-----|-------------------------------|---|----------|
| 21. For each monitoring question, identified data pathway(s) (path for monitoring results to a final decision, decision-maker) |      |            |     |                               |   |          |
| 22. List of ambiguous terms defined such as healthy, significant, restored, quality, etc.)                                     |      |            |     |                               |   |          |
| Other?   |      |            |     |                               |   |          |

\*DOC=Documentation, \*M & A= Monitoring and Assessment

- 5. To make this assessment useful, determine what your gaps and needs are regarding this step in order to focus your effort in completing this step.**

**Worksheet 6.2.a Self Assessment Step 6 Worksheet and Products to be completed Prior to this Step, Part 2.**

*Part 2 Products to be completed before this step, in order to complete this step*

| Item   | Response |
|--|----------|
| Desired set of outcomes or results that the monitoring and assessment activities will be designed to help achieve:   |          |
| Assessment Types, specific combination of one monitoring reason and data use(r):   |          |
| For each Assessment Type, the list of specific monitoring questions:   |          |
| For each monitoring question, the targeted decision makers, the type of decisions they will make and the information they need to make them (as specific as possible): |          |
| Watershed(s) and Water bodies of focus:  |          |
| Physical attributes of Water bodies (status, use, etc.)  |          |
| Existing Data or monitoring efforts:   |          |
| Indicators, benchmarks and criteria list:  |          |
| List of monitoring locations/rationale:  |          |
| List of monitoring frequencies:  |          |
| Methods list, list of data quality objectives (methods, how good does the data need to be for decision makers), quality assurance and control measures)                |          |
| What you know now about decision makers data-to-information needs, analyses, interpretation and reporting  |          |

**For Sheet 6.3.a      Document the Data Pathway for each monitoring question and use as information blue print communication tool. Data Pathway is the path each data point travels to be validated, turned into information and delivered.**

*Use the following Information Blue Print that can serve as a Monitoring Question Data Pathway Fact Sheet. The “set” of Fact Sheets per Assessment Type provide an excellent, detailed communication tool for what you are doing and not doing as well as a simple tool to update as implementation evolves.*

**Worksheet 6.3.a Information Blue Print - Data Pathway Fact Sheet for each monitoring question per Assessment Type**

See Background and Content for explanation of each item. Edit to serve your needs.

| Assessment Type:   | Reason:       | Use(r): |
|--|---------------|---------|
| <b>Monitoring Question: ____ of ____:</b>  |               |         |
| Information Blueprint #  | Your response |         |
| 1. Watershed Vision and Desired Outcomes this is design to help  |               |         |
| 2. Scoping Inventory needs related to Assessment Type  |               |         |
| 3. Existing data or monitoring efforts that are of quality to use here   |               |         |
| 4. Targeted Decision Makers  |               |         |
| 5. Technical info needed by Decision Makers (what, where, when, how, raw data mngt):   |               |         |
| 6. DQO's and Qa/Qc needed  |               |         |
| 7. Decision makers needs for analyses (summaries, illustrations, metrics, indexes, statistics, etc.)   |               |         |
| 8. Decision Maker Benchmarks   |               |         |
| 9. Decision makers needs for interpretation, conclusion or recommendations (assessment protocol, criteria, method, process, statistical hypothesis): |               |         |
| 10. Communication & Delivery needs of Decision-maker, organization/others  |               |         |
| 11. <i>Monitoring question</i> is met when "XYX.....":   |               |         |
| 12. Monitoring System Product:   |               |         |
| 13. Evaluation Date  |               |         |
| 14. Assumptions and External Factors   |               |         |
| 15. Definitions for ambiguous terms:   |               |         |
| 16. Ball Park Estimate of \$   |               |         |

**For Sheet 6.6.a** Place Products in your *Watershed Monitoring and Assessment Plan*.

Information Blue Print – Data Pathway Fact Sheet for each Monitoring Question per Assessment Type

**Worksheet 6.6.a** Add products of Step to *Monitoring and Assessment Plan*.

**If you completed any Steps this Worksheet is cumulative, use that document. If you have not you complete that aspect that is highlighted for your plan documentation. \*Italics mean a sub plan that might be attached or live somewhere else, location of document and contact is what would go in the plan.**

I. People Design, Phase 1

- A. Shared Watershed Vision and Desired Outcomes (Step 1)
  - 1. Logic Model of Desired Outcomes/Results and activities/target audiences to employ to achieve outcomes
- B. Keepers of the M & A Plan (Step 1)
- C. Watershed Boundary (Step 2)
- D. Water bodies of Interest (Step 2)
- E. Scope Inventory Master List\* (Step 2)
  - 1. Physical Inventory \* (Step 2)
  - 2. People Inventory\* (Step 2)
  - 3. Information Inventory\* (Step 2)
    - a. Existing Monitoring Efforts (Step 2)
    - b. Existing Data Sources (Step 2)
  - 4. Inventory Action Plan\* (Step 2)
- F. Assessment Type(s) List – Monitoring Reason + Use (Step 3)
  - 1. Monitoring Question(s) (Step 4)
  - 2. Targeted Decision Maker(s) (Step 5)
    - a. Information Needs (Step 5)
  - 3. Information Blue Print – Data Pathway Fact Sheet Per Monitoring Question\* (Step 6)

II. Technical Design, Phase 2

- A. What (Indicators, Benchmarks, etc.) and why? (Step 7)
- B. When and why? (Step 8)

- C. Where and why? (Step 9)
- D. W(how) will meet data quality objectives? (Step 10)
  - 1. Data quality objectives (Step 5 and 10)
  - 2. Quality Assurance and Control Measures (Quality Assurance and Control Plan)\* (Step 10)
- E. Data Management for Raw Data (Data Management Plan Part 1)\* (Step 11)

### III. Information Design, Phase 3

- A. Data Summary and Analyses (Step 12)
  - 1. Starting Point (Step 12)
  - 2. Changes (Later)
- B. Data Interpretation, Conclusions, Recommendations
  - 1. Starting Point (Step 13)
  - 2. Changes (Later)
- C. Communication and Delivery
  - 1. Starting Point (Step 14)
  - 2. Changes (Later)
- D. Management Plans to Generate Information (Data Management Plan Part 2)\* (Step 15)

### IV. Evaluation Design, Phase 4

- A. Who Will Do What? (Step 16)
  - 1. Task Identification Matrix (Step 16)
  - 2. Communication Structure and Tools (Step 16)
- B. Evaluation Plans (Step 17)
  - 1. Evaluation Plans for M & A Components (Step 17)
  - 2. Evaluation Plans for M & A Implementation (Step 17)
  - 3. Evaluation of inter/intra M & A Activities (Step 17)
- C. Documentation and Communication (Step 18)
  - 1. M & A Plan (**this document**, updated Sub documents) (Step 18)
  - 2. Communication and Peer Review Plan (Step 18)
  - 3. Action Plan\* (Step 17)

**For Sheet 6.7.a**      **Place your identified gaps and needs regarding this step in the *Action Plan* (what you need to plan to complete this step and or overall monitoring and assessment plan).**

**Worksheet 6.7.a**      **Final *Action Plan* Part 1, Summary:**

*If you have completed each Step, or for those you have, you have a cumulated list of gaps and needs related to that Step. Use that same worksheet/document. If you did not complete each Step, look at what each Step is supposed to accomplish and record what your gaps and needs are related to that topic. The goals are to get the gaps and needs in one place to evaluate and prioritize.*

|  |
|--|
| <b>Phase 1 Step 1: (completed in Step 1)</b>   |
| <b>Phase 1 Step 2: (completed in Step 2)</b>   |
| <b>Phase 1 Step 3: (completed in Step 3)</b>   |
| <b>Phase 1 Step 4: (completed in Step 4)</b>   |
| <b>Phase 1 Step 5: (completed in Step 5)</b>   |
| <b>Phase 1 Step 6:</b>   |
| <b>Phase 2, 3 and 4 Steps: Will add Action and Needs as complete each Step and at the end prioritize</b> |

## Background and Content

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Summarize the Data Pathway for Each *Monitoring question* per Assessment Type by Completing an Information Blueprint

If you have completed the previous Steps with any detail creating a blue print is easy. The hard work is already done, this step just summarizes it in a fashion you could hand it to someone and they would know what you were doing and not doing. We aren't suggesting this is the only format; just that it is very useful to summarize the orientation of the monitoring activities for your watershed assessment

Your focus is on each *monitoring question*, illustrating the connection of the objective to the data users, data uses, *monitoring reason*, outcome and vision. From this blue print you design the remaining monitoring components and data pathways that come after the *monitoring question* has been determined. This includes the W's of monitoring (steps 7-11) and data to information and utilization (steps 12-17) and monitoring evaluation (steps 18-21). The information blueprint is the documentation that explains **why** you are monitoring.

To create an information blueprint, complete one blueprint, all the boxes, for each *monitoring question*. Use any or all of the information generated in Steps 1 - 5. An example of a blueprint that contains all relevant information is provided.

**Alter it to adapt to your needs. You will be finalizing each Blue Print or Data Pathway Fact Sheet per *monitoring question* in the next two Phases and Steps.**

| Assessment Type: ____  | Reason (Step 3)              | Use (Step 3)  |
|--|------------------------------|---------------|
| <b>Monitoring question (step 4): ____ of ____</b>  |                              |               |
| Information Blueprint #  | Process/Step                 | Your response |
| 1. Watershed Vision and Desired Outcomes this is design to help  | Step 1                       |               |
| 2. Scoping Inventory needs related to Assessment Type  | Step 2                       |               |
| 3. Existing data or monitoring efforts that are of quality to use here   | Step 2, 5, Phase 2           |               |
| 4. Targeted Decision Makers  | Step 5                       |               |
| 5. Technical info needed by Decision Makers (what, where, when, how, raw data mngt):   | Step 5, Phase 2              |               |
| 6. DQO's and Qa/Qc needed  | Step 5, Phase 2              |               |
| 7. Decision makers needs for analyses (summaries, illustrations, metrics, indexes, statistics, etc.)   | Step 5, Phase 3              |               |
| 8. Decision Maker Benchmarks   | Step 5, Phase 3              |               |
| 9. Decision makers needs for interpretation, conclusion or recommendations (assessment protocol, criteria, method, process, statistical hypothesis): | Step 5, Phase 3              |               |
| 10. Communication & Delivery needs of Decision-maker, organization/others  | Step 5, Phase 3              |               |
| 15. <i>Monitoring question</i> is met when "XYX.....":   | Step 5                       |               |
| 13. Monitoring System Product:   | Step 3, Step 18, 19          |               |
| 14. Evaluation Date  | Step 4,5, Step 19            |               |
| 12. Assumptions and External Factors   | Step 19                      |               |
| 11. Definitions for ambiguous terms:   | Step 5, Phase 2, 3 & Step 19 |               |
| 16. Ball Park Estimate of \$   | Step 5, Phase 2 & 3          |               |

*Headers:*

Information Blueprint / Data Pathway Fact Sheet: For this *monitoring question* the blueprint summarizes the pathway for the data to be generated, quality checked, managed, analyzed, interpreted, communicated and delivered to an identified decision maker(s) and evaluated. Supporting components providing the left bookend include, the assessment type, *monitoring reason*, data use, *monitoring question* designed to achieve a desired outcome/watershed vision and existing data/efforts. Supporting components providing the right bookend include, identifying assumptions and external factors/boundaries, identification of products, evaluation date, defining ambiguous terms, and a cost estimate.

## Phase 1: People Design: Build a Foundation | Step 6: Summarize Info Blue Print, Page 18

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Assessment Type: What is the assessment type identification number; use ours A-II, C-III or one of your own, project id?

Monitoring reason: What specific *monitoring reason* is this *monitoring question* serving? This is a critical step to choosing an assessment type.

Data Use: What specific use will the results of this monitoring activity serve? This is a critical step to choosing an assessment type. You can have more than one use per reason.

Monitoring question: State the specific *monitoring question* or question that will be answered by the following data pathway or information in the blueprint

Watershed Vision and desired outcomes: The reason for monitoring and assessment activities. What do you want your watershed to look like and how will you know you achieving it, by identifying measurable outcomes or results.

Scoping Inventory needs related to monitoring questions: What inventory do you have and what do you need regarding this *monitoring question*?

Existing Data/Efforts: In your inventory did you discover any existing data that passed a quality check or any entities actively gathering information that would be appropriate to either answer or help you answer this *monitoring question*? Opportunities to collaborate, leverage resources, increase credibility, increase coverage and impact?

Targeted Decision Makers: Who is the data and information designed to be delivered to?

Decision Makers information data generation technical design needs. Summarize what specific information do your targeted decisions makers need to make the decision you desire? What, when, where, how will data be generated and managed? If this is your decision maker information exit point, how will you deliver the validated raw data?

Decision Makers Analytical Needs Analyses Needs: How does your decision maker need you to analyze the raw data? How do they do it with their own data? If you don't know this now, you will try and discover or define it in Phase 2 and 3. If this is your decision maker information exit point, how will you deliver the analyzed data?

Decision Makers Interpretation, Conclusions and or Recommendation Needs: How does your decision maker need you to interpret, make conclusions or recommendations with the analyzed data? How do they turn data into information? If you don't know this now, you will try and discover or define it in Phase 2 and 3. Your decision maker information exit point, might be interpretation, conclusions and or recommendations, how will you deliver this information?

Decision Maker Communication and Delivery Needs: Where does each decision maker need you to deliver, raw data, analyzed data, data with interpretations, data with interpretations and conclusions, or data with interpretations, conclusions and recommendations? How does your decision maker need the information to make their recommendation and/or take action? How will you communicate or deliver your data and information to the decision maker? What do they need when and how to make their recommendation and how will you know? At a minimum this is the "act" of getting the information you generated to the targeted users or decision makers for the decision you want them to make.

Monitoring question is met when \_\_\_\_\_ . This is how you will know if the objective or question was answered. This is what you evaluate and take back through design modification. It is what helps you track your progress with this output in achieving the associated outcome and larger vision.

Monitoring System Product: What will be produced by the activities conducted for this *monitoring question*? This is important to track products for each objective, for funders, supervisors, constituencies, evaluation, etc.

Evaluation Date: What is the date you plan to evaluate this *monitoring question*, and assumption is the process of how is identified as well.

Assumptions and External Factors: What are the boundaries that go with successfully implementing a data gathering, analyses, interpretation, communication and delivery for this *monitoring question*?

Definitions of ambiguous terms: this is important to define terms that mean different things to different people, or are not measurable without a definition. For example, clean. How clean is clean? If we clean up our rivers so that it is equivalent to deionized water and nothing can live in it-that is one definition of clean. Common terms include healthy, significant, integrity, diversity, and impaired. You will use decision makers definitions if appropriate and may need to define these things yourself. The important act is that you define them, so you know have succeeded or failed in your measurement. Even it the definition is not perfect, it is better than not having a definition.

Ball Park Estimate: what is your ball park cost estimate for human and other resources to implement the data pathway for this *monitoring question*?

### *Organization Relevance and Recalibration Check*

Once you have all the information blueprints for each Assessment Type, it might be time to review them in context with your organization's mission, values and resource capacity. If need be prioritize, do less better, or do more if can, tweak as need, but check in to be confident at this stage monitoring is appropriate, doable and worth continuing to plan Phase 2, 3 and 4. At the end of Phase 2, you will conduct another evaluation with resource allocation defined in greater detail.

### Case Study 1:

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### Case Study 2:

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## References

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## Resources

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Contents in Phase 1, *Step 6 Resource Guide*:

## Closure of Phase 1 / Transition to Phase 2

### What you potentially accomplished:

In Phase 1, Steps one through six, you provided the foundation for planning the remaining components of a Watershed Monitoring and Assessment Plan. This foundation is the basis for building and implementing a scientifically defensible monitoring and assessment effort that can be evaluated. This effort connects a sample design with the people the data was intended to serve as well as the science questions it is intended to answer. Evaluation is important for both aspects.

### What you potentially produced:

- ✓ A watershed vision and associate outcomes/results to indicate vision success
- ✓ Outcome Outputs in the form of Assessment Types or specific monitoring reasons and data uses
- ✓ For each Assessment Type and specific data purpose and use:
  - Refinement of each monitoring reason by listing all monitoring questions
  - Refinement of each use for this purpose by identifying each decision maker, decision they would make and information needed to make decision
  - For each monitoring question and decision maker, the data pathway or *information blue print*
- ✓ *Master Inventory List* (physical, people and information)
- ✓ *Inventory Action Plan* (to gather information data don't have)
- ✓ *Monitoring and Assessment Action Plan* started (capacity and needs to consider in future to complete monitoring and assessment / decision maker outputs for outcomes/watershed vision)
- ✓ Documentation of a watershed *Monitoring and Assessment Plan* started
- ✓ Relevance check with Organization mission, goals, values and resources

*Italics* = sub-plans or items produced in planning process, to edit with information from remaining Phases

### Where will you go from here?

Results from Phase 1, Steps one through six, provide the foundation and information for planning:

- ✓ the technical sample design, Phase 2, or how you will collect and generate data, check the quality of the data and manage the raw data
- ✓ the information design, Phase 3, or how you will turn data into information through analyses, interpretation, communication and delivery
- ✓ the evaluation design, Phase 4, how you will identify who is responsible for all parts of the monitoring and assessment plan, how you will evaluate this plan, implementation of this plan, each monitoring question and Assessment Type, how you can align multiple Assessment Types within your organization or watershed, and finally how you will document and communicate your plans.