



# BEST PRACTICE GUIDELINE H3

# WATER REUSE AND RECLAMATION

William Pulles



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# Structure of BPG H3

- Chapter 1: Introduction
- Chapter 2: Definitions
- Chapter 3: Objectives and key considerations
- Chapter 4: Process for development of a water reuse and reclamation plan
- Chapter 5: Legal and regulatory role of water reuse and reclamation



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# BPG H3: Introduction & Hierarchy

Prevent or minimise pollution/contamination of water used by implementing necessary management measures or strategies



**Reuse or Reclaim contaminated water in cases where complete pollution prevention was not possible**



Treat water that cannot be reused or reclaimed



Reuse treated water



Discharge or Disposal of excess Water



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# BPG H3: Introduction

- Application and optimisation of reuse and reclamation is mandatory
- Reuse and reclamation should form integral part of IWWMP
- Scrutiny of mine water balance will indicate potential for reuse & reclamation where:
  - Optimum pollution prevention fails to eliminate pollution
  - Large volumes of water are used and/or disposed
  - Good quality water is imported while poorer quality water is lost
  - Better quality water than necessary is being used



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# BPG H3: Introduction

Benefits of optimised water reuse & reclamation are:

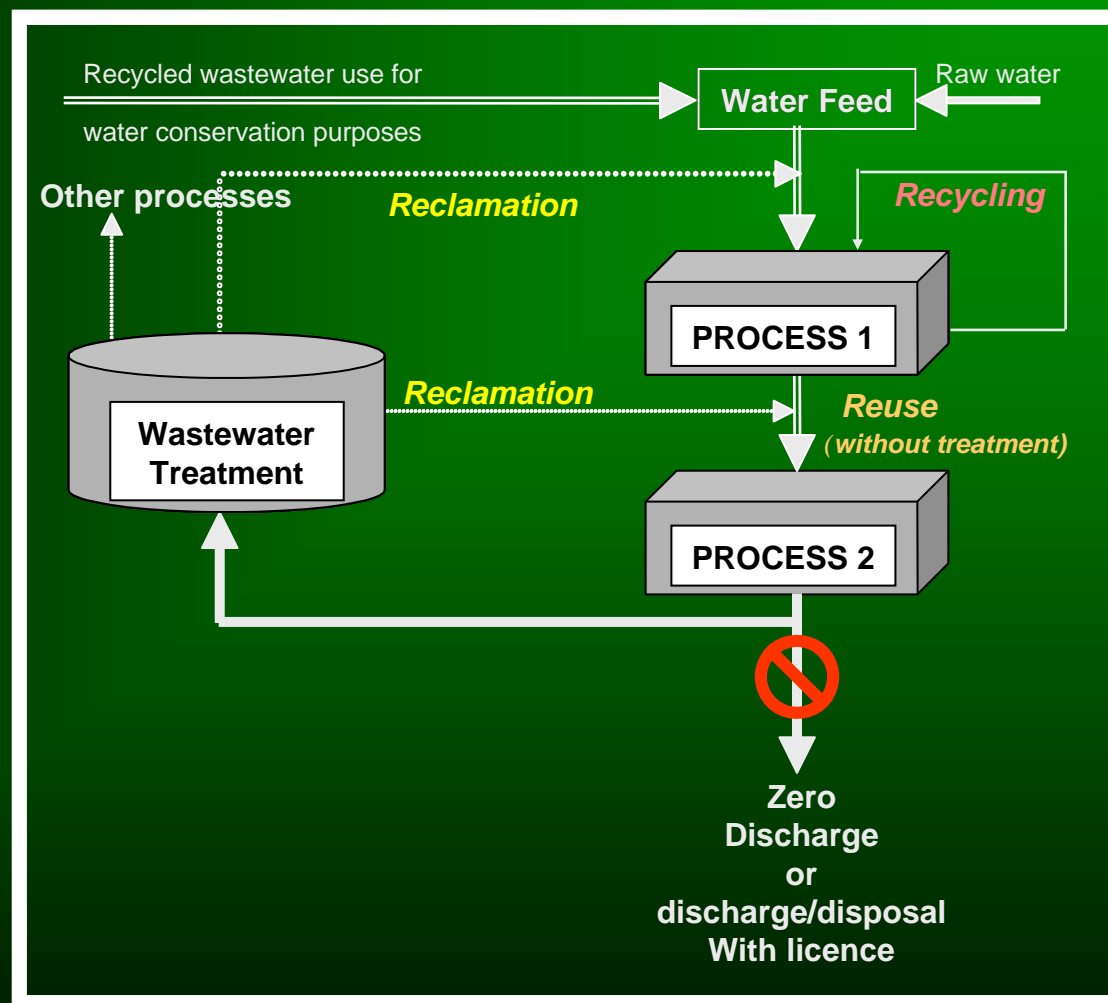
- Cost savings in raw water intake and disposal (reduced WDCS) and reduced need for expensive water treatment
- Compliance with DWAF hierarchy
- Conservation of a scarce resource
- Protect public health and environment



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# Definitions



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# Objectives of BPG H3

- To clearly define the process that should be applied by a mine when developing a mine water reuse and reclamation plan **and** that will be applied by DWAF when reviewing/evaluating a mine water reuse and reclamation plan within the bigger context of the mine's IWWMP.
- To define a process that, when applied, will clearly indicate to DWAF that water reuse and reclamation have been applied effectively and that the mine may move to negotiations regarding discharge or disposal if required.
- To define the structure and content of a report or section of a report (section of IWWMP) or product that should be submitted to DWAF to enable the review/evaluation of the mine water reuse and reclamation plan or IWWMP.



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# Four key considerations

- ❖ **Pollution prevention consideration:** Deterioration of water quality must be prevented wherever possible and minimised where complete prevention is not possible because cleaner water is easier/cheaper to reclaim.
- ❖ **Water conservation consideration:** Losses of water and unnecessary consumptive use of water must be minimised.
- ❖ **Fitness-for-use consideration:** Water users within the mine must be provided with water of a quality as poor as possible but good enough that it does not cause significant user, water quality, product quality or process related problems (scaling, corrosion, etc).
- ❖ **Sustainability consideration:** The plan must be sustainable over the life cycle of the mine and over different hydrological cycles.



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# Pollution prevention consideration

- Ensure that all possible opportunities for the prevention of water pollution have been identified and applied.
- Ensure that, in the case where pollution prevention is not possible, the necessary management measures are implemented to minimize impacts as far as possible.
- Ensure that water use practices do not result in unnecessary water quality deterioration.
- Minimise contact between water and major pollution sources where possible.
- Separate waters based on degree of contamination to make reclamation and reuse easier.



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# Conservation consideration

- Prepare and evaluate a detailed water and salt balance (BPG G2) for the mine.
- Ensure that evaporative losses from “clean” water storage dams (limit exposed surface area) and evaporative cooling systems are minimised.
- Limit evaporative cooling systems where possible and investigate other types of cooling systems (air etc).
- Ensure that seepage/overflow losses from storage facilities are minimised – provide adequate storage capacity
- Purchase raw water only for processes requiring such good water quality.
- Evaluate the process technology being used in terms of its water use requirements and whether or not alternative technologies could be applied



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# Fitness-for-use consideration

- Establish clear and accurate water quality requirements for all mine-related water uses.
- Establish water quality constituents affecting/impacting on product quality or yield and/or process optimisation /performance.
- Optimally match uses with the required water (each user to have poorest possible water quality supplied), taking cognisance of economic and practical restraints with regard to having different water reticulation systems.
- Institute monitoring to ensure that adverse effects of unacceptable reclaimed water quality are not being manifested, i.e. corrosion, scaling, reduced process performance.



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# Sustainability consideration

- Develop water and salt balance projections (BPG G2) for future mining scenarios, including mine closure and post-closure.
- Apply considerations 1, 2 and 3 to each projected water and salt balance and integrate the results into a coherent Water Reuse and Reclamation Plan that is valid over the mine's life-cycle.
- Long-term planning and sustainability should be considered and therefore predictions on water quality and quantity into the future should also be incorporated (predictive modelling – BPG G4) to ensure that reuse and reclamation plans are not affected by future processes.
- Document and motivate the integrated water reuse and reclamation plan for consideration by DWAF.



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# Process to develop WRRP

Different considerations based on mine life cycle phase:

- Planning & feasibility phase – focus on design considerations after optimising pollution prevention
- Operational phase – focus on implementation, review, continuous improvement, monitoring
- Decommissioning & closure phase – focus on identifying best reuse options, e.g. irrigation

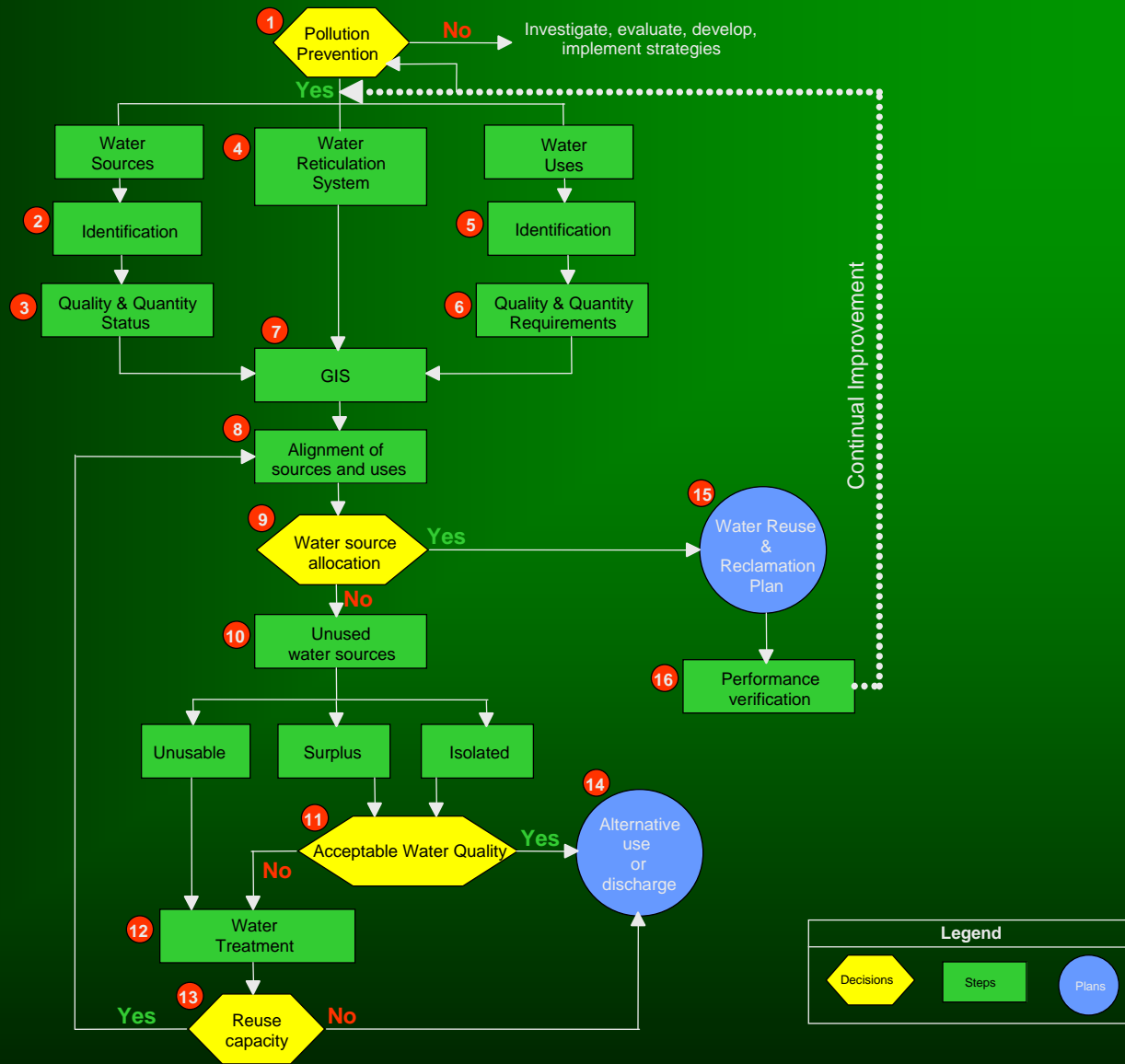


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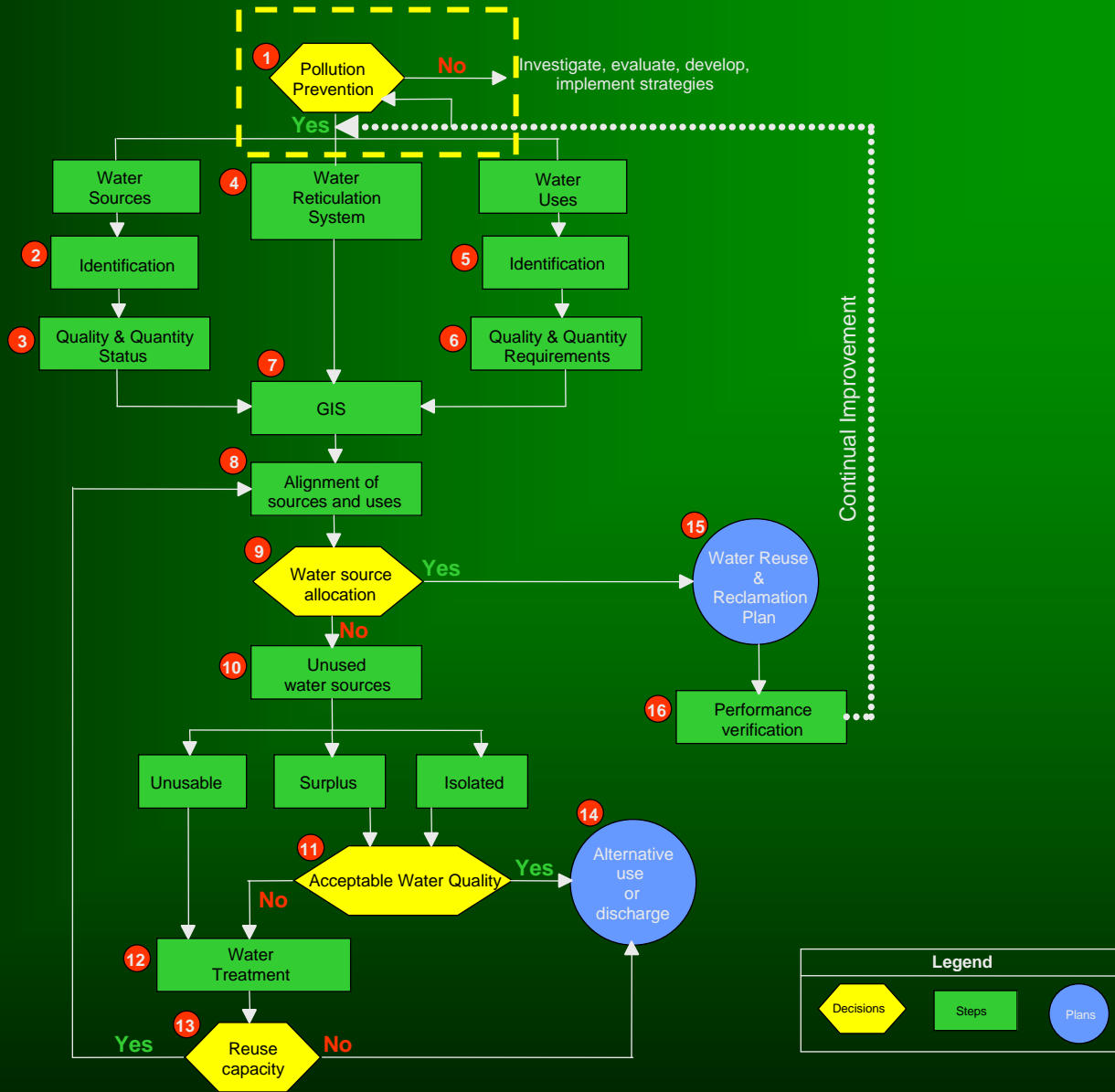


# Process to develop WRRP





# Process to develop WRRP





# Step 1: Pollution prevention

## *Purpose:*

To ensure that all pollution prevention strategies have been applied.

## *Method:*

Investigate, evaluate, develop and implement appropriate pollution prevention strategies wherever possible, e.g. early recognition of the potential for acid mine drainage and the adoption of appropriate management strategies (encapsulation, selective handling, clean and dirty water separation, etc) – use BPG H2

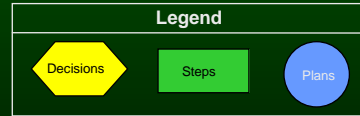
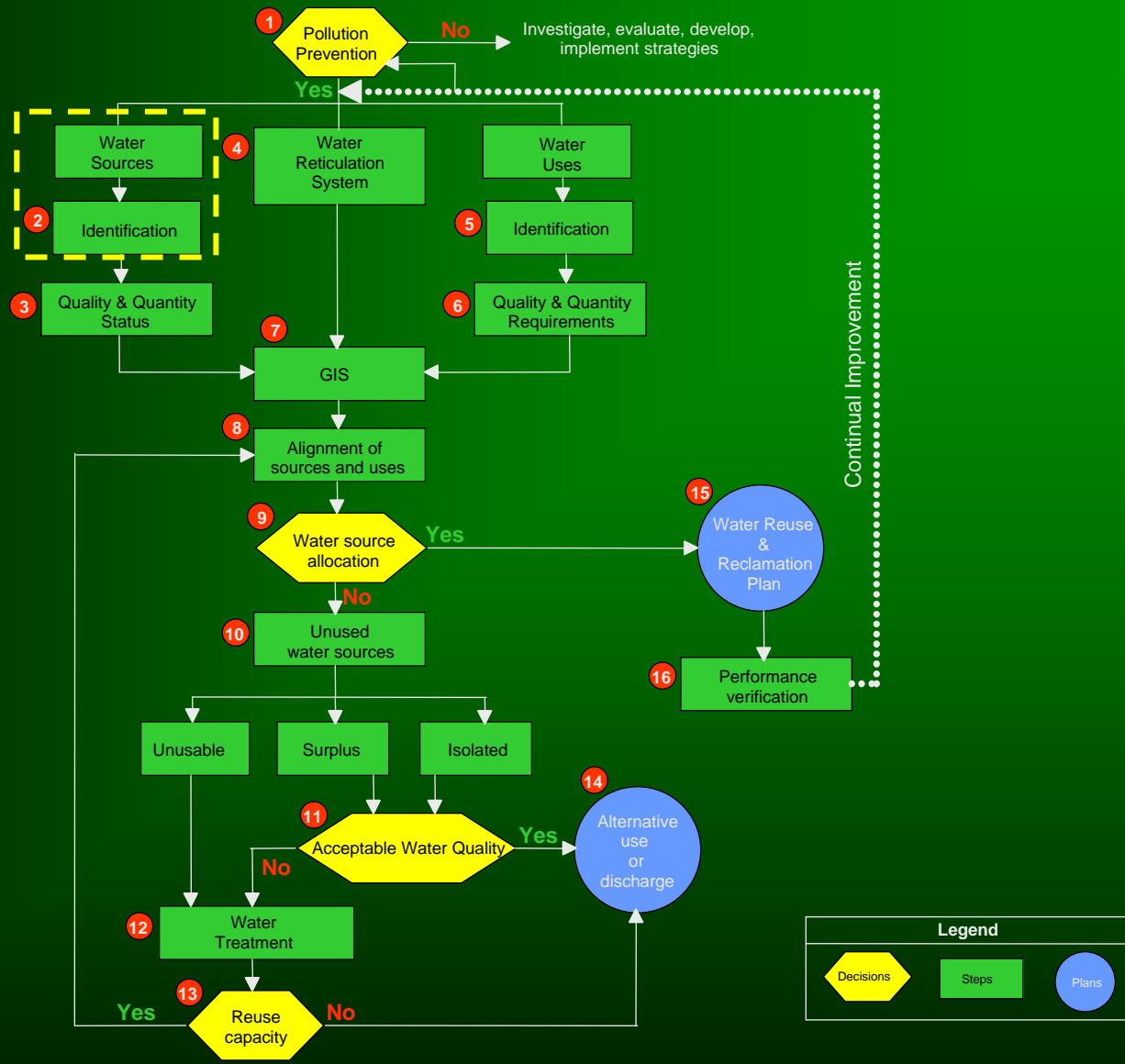


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# Process to develop WRRP





## Step 2: Identify water sources

### *Purpose:*

To ensure that all possible sources of usable water, available on the mine, have been identified.

### *Method:*

- Locate where processes are fed with raw water and establish where these processes are fed from (dams, boreholes, natural water bodies, service providers etc).
- Locate all water using processes including utility services and establish where their water originates from.
- Locate all points where water or effluent is generated.
- Locate all water or contaminated water storage and collection areas.

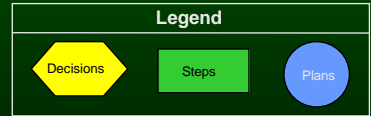
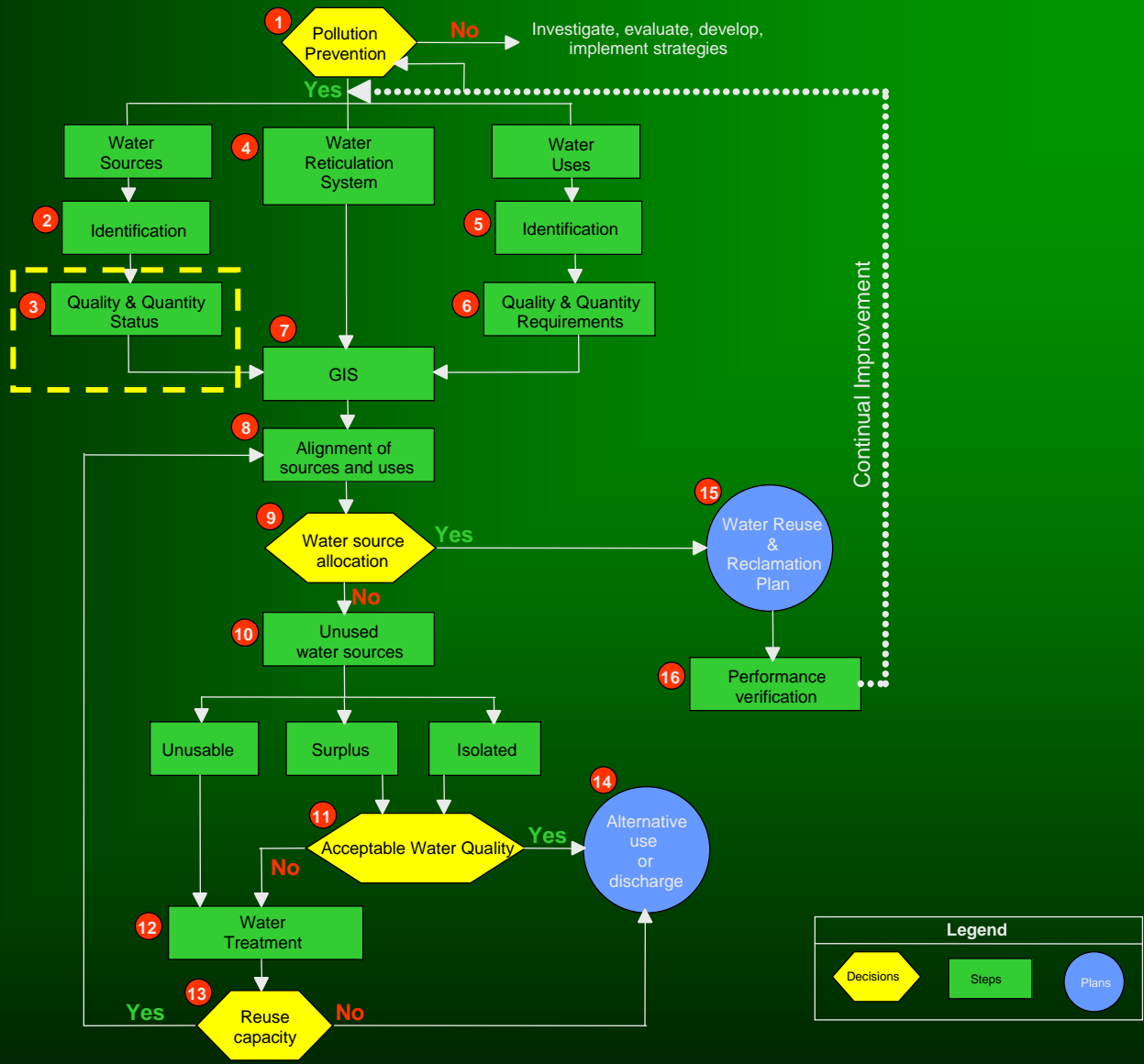


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# Process to develop WRRP





## Step 3: Water source quality & flow

### *Purpose:*

To define the water quality and flow status as well as the variability of the possible water sources identified in Step 2.

### *Method:*

Characterise the water streams/sources with respect to flow rate, quality and variability data through a monitoring system. Base the characterisation on information over the past 5 years, if possible.

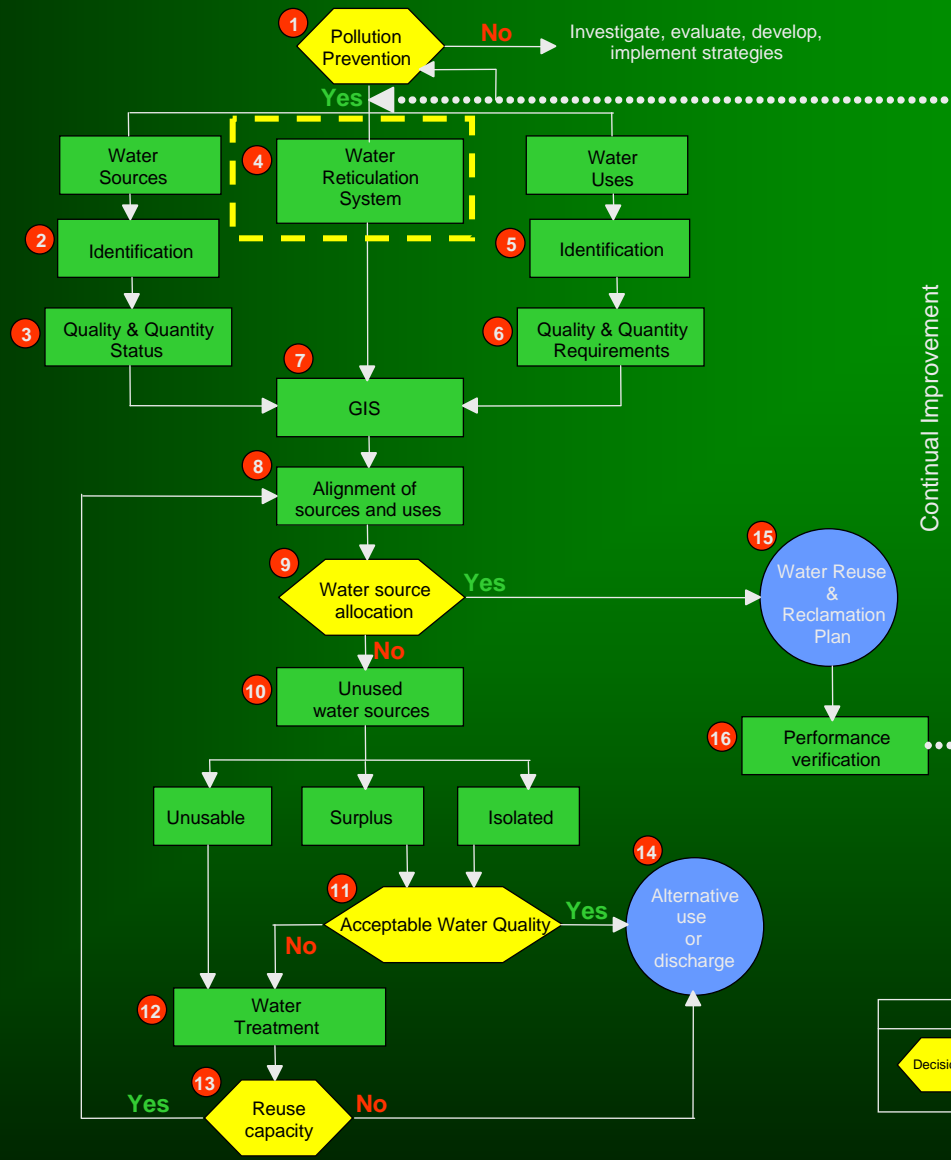


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# Process to develop WRRP





# Step 4: Water reticulation system

## *Purpose:*

To assess (identify and define) current/existing water reticulation systems and ability thereof to support water reuse and reclamation.

## *Method:*

- Assess current/existing water reticulation system.
- Identify opportunities for reusing effluent water from one process as influent water to another process.
- Establish where water reticulation networks may need to be installed or extended/modified once reuse pathways are validated.
- Check pipe sizes, pump rates etc with requirements.
- Assess adequacy of water storage facilities within the reticulation system and establish necessity of additional requirements.

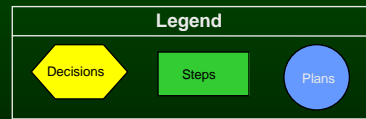
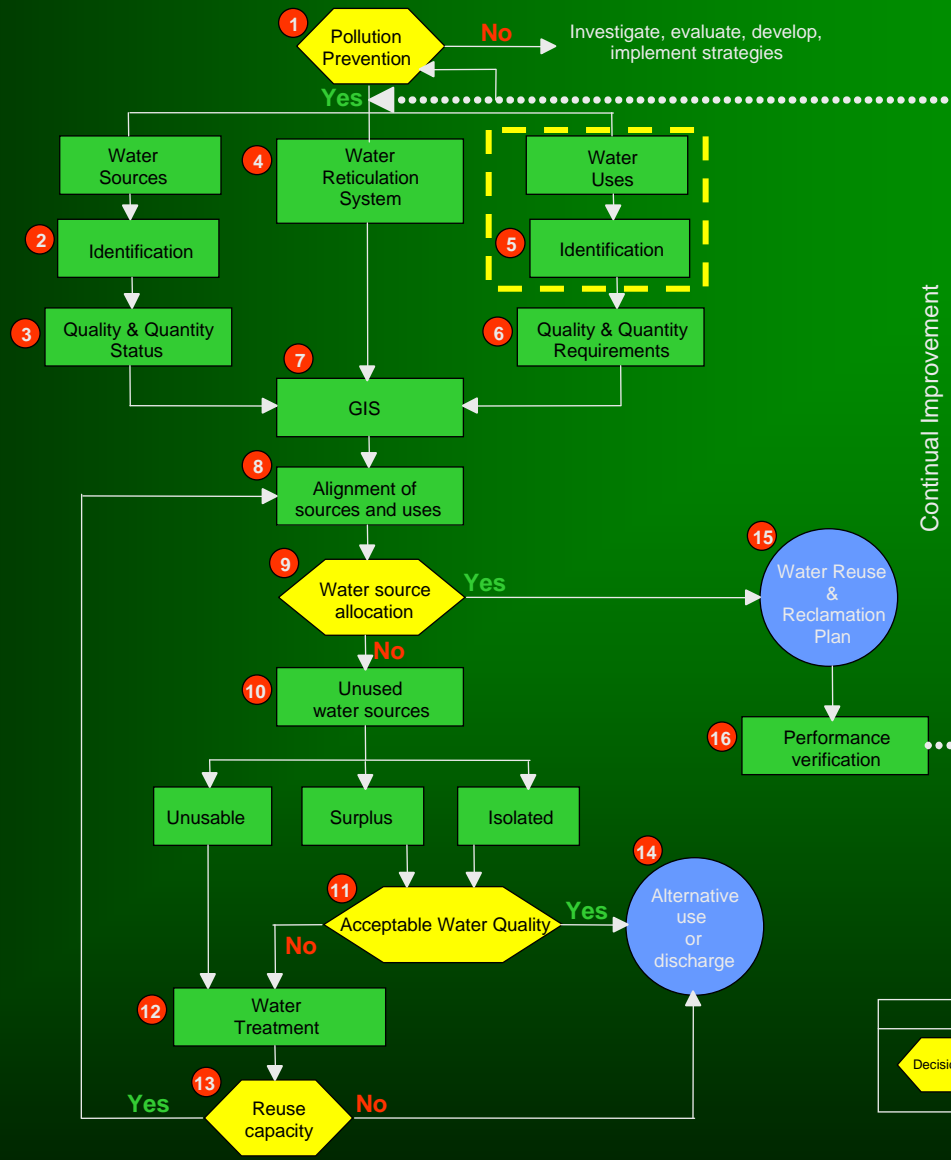


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# Process to develop WRRP





# Step 5: Identify mine water uses

## *Purpose:*

To identify all mine water uses, i.e. areas/processes on the mine requiring water for its operation.

## *Method:*

- Conduct a water use inventory. A list of existing and potential mine-related uses needs to be compiled because water quality requirements are intrinsically linked to and based on use requirements (Step 6).
- Identify both direct and indirect water uses. Water use on a mine can range from potable use to use for mineral processing, cleaning, dust suppression, transport, irrigation, cleaning, etc.

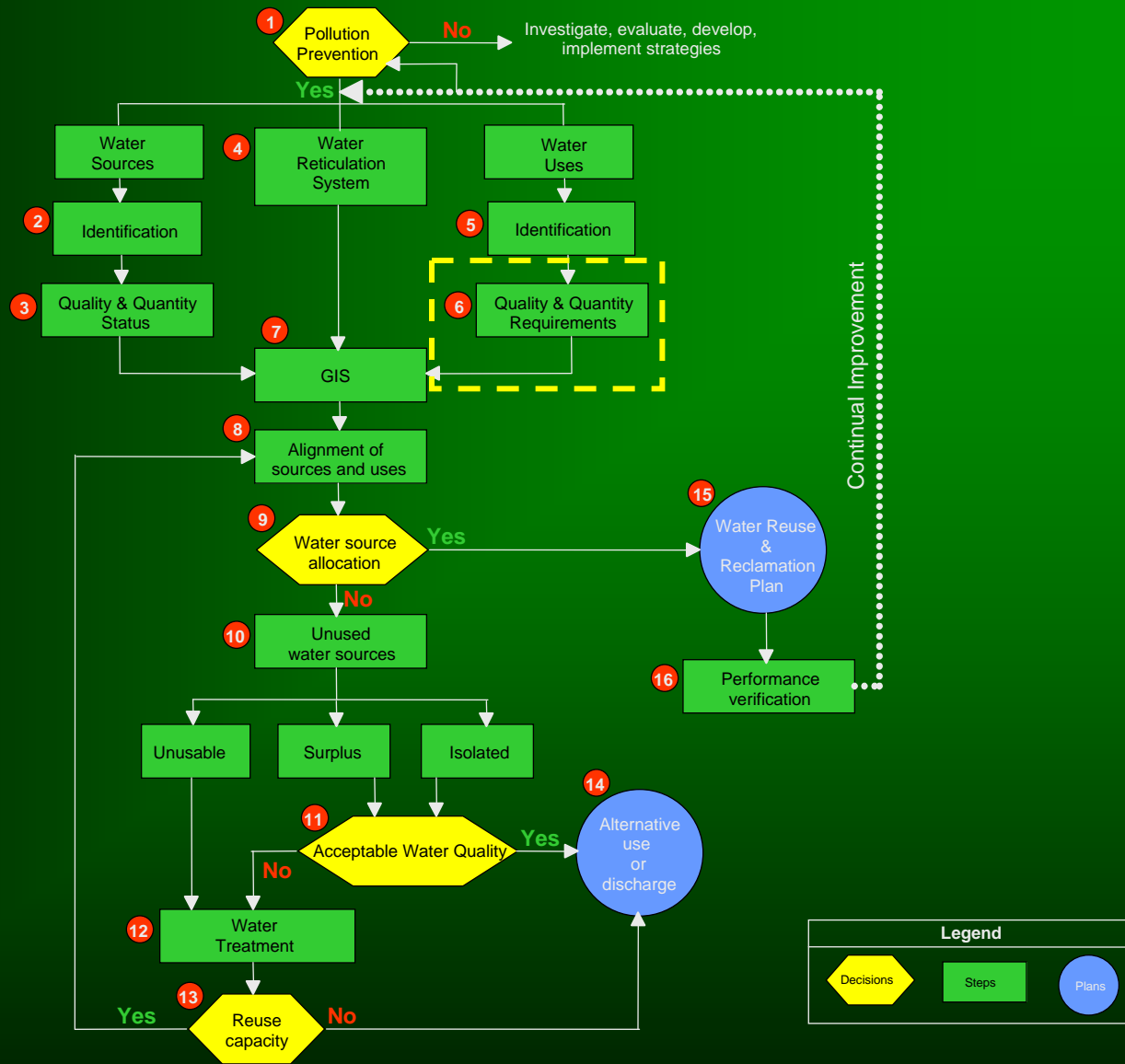


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# Process to develop WRRP





# Step 6: Water use quantity and quality requirements

## *Purpose:*

To define water quality and quantity requirements of all mine water uses.

## *Method:*

- Consider water quality parameters that affect/impact on product quality/yield and/or process performance/optimisation.
- Establish fit-for-purpose quality and quantity criteria.
- Consider the water quality needs of the mine-related use and not only the water quality currently supplied (For example: supply of potable water for a use that actually requires water of a lesser quality).
- Determine potential acceptance of water quality and quantity at proposed standards (without treatment). If unacceptable, determine additional treatment required to render water quality and quantity of an acceptable standard.
- Group uses with similar water quality requirements together to provide a number of different water quality groups/categories.
- Aim to reuse water with the minimum amount of treatment.

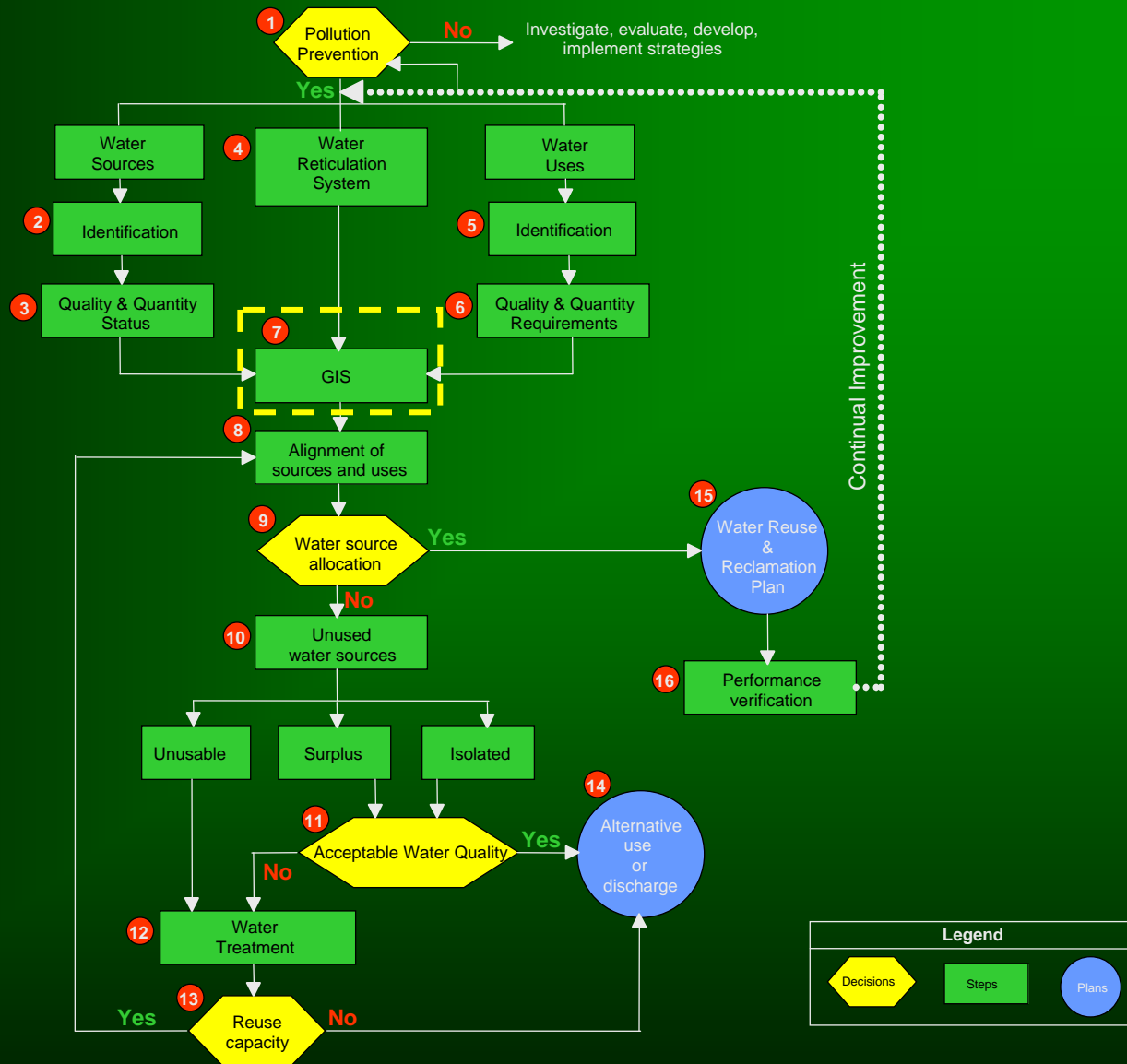


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# Process to develop WRRP





# Step 7: GIS

## *Purpose:*

To develop geographically referenced plans showing water sources, water uses and existing reticulation system(s) in order to assist in linking these. This will support effective water and waste management and the compilation of accurate water and salt balances for the mine.

## *Method:*

- Create a flow sheet model (schematic flow diagram) of the water reticulation system(s).
- Select an appropriate tool to use for data and information management.
- Validate reliability of data before entering into the information management system.

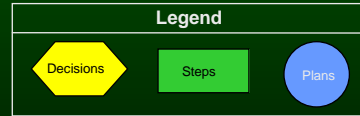
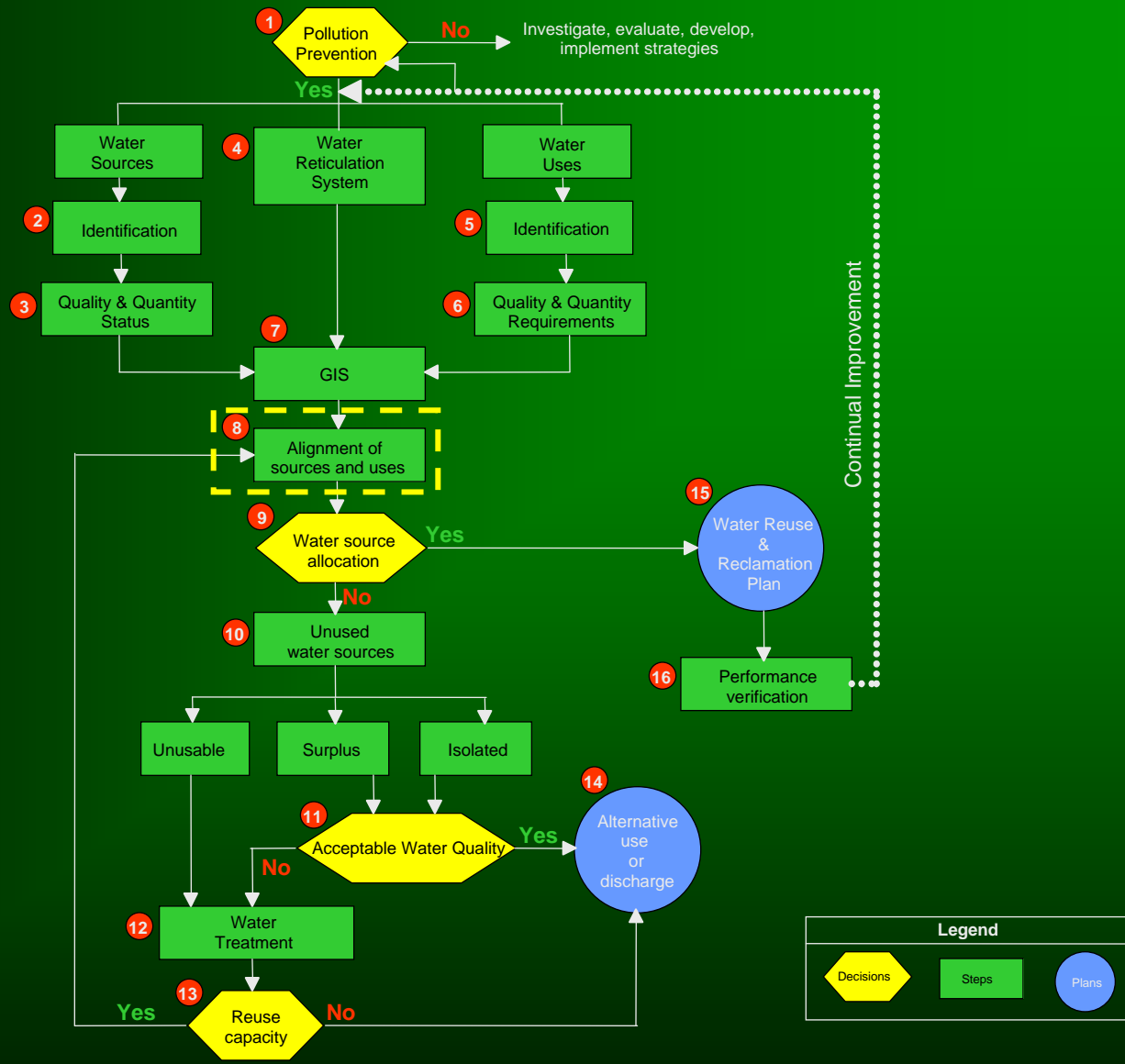


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# Process to develop WRRP





## Step 8: Aligning water sources to water users

### *Purpose:*

To align and allocate water sources to water uses, taking into account all previous steps.

### *Method:*

- Align and allocate recycled water quality and quantity to various applications or water uses.
- Achieve the minimum use of raw water or optimal flow configuration in the particular system of operations.
- Optimise the water reticulation system as far as possible. Conceptual designs derived from water allocation analysis steps (Appendix B) must be comparatively evaluated to choose the best option. The alternative analysis includes an evaluation of technical, monetary, environmental and social factors.
- Ensure true and accurate cost analysis since decisions are based on financial considerations.

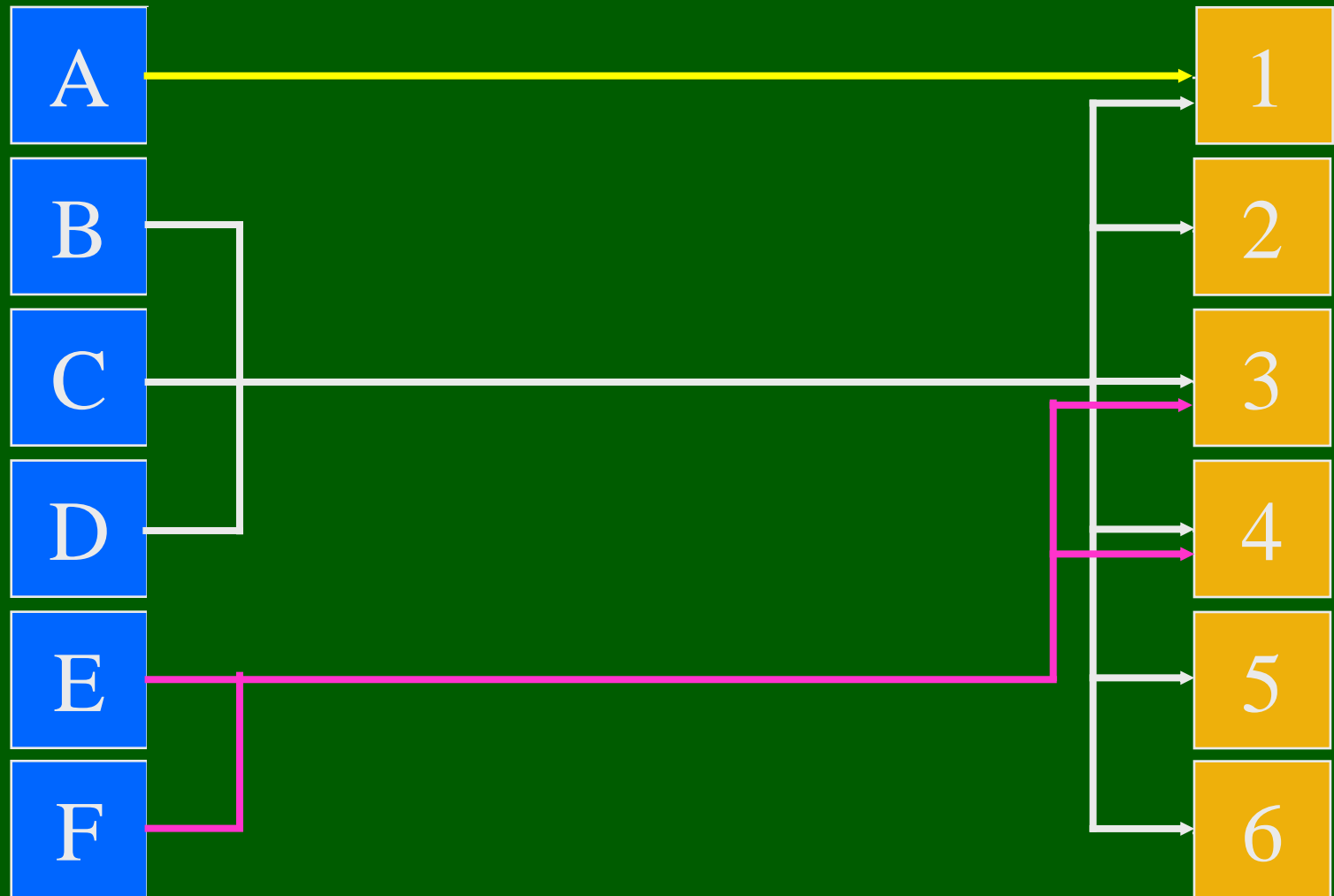


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# WATER SOURCES

# WATER USERS

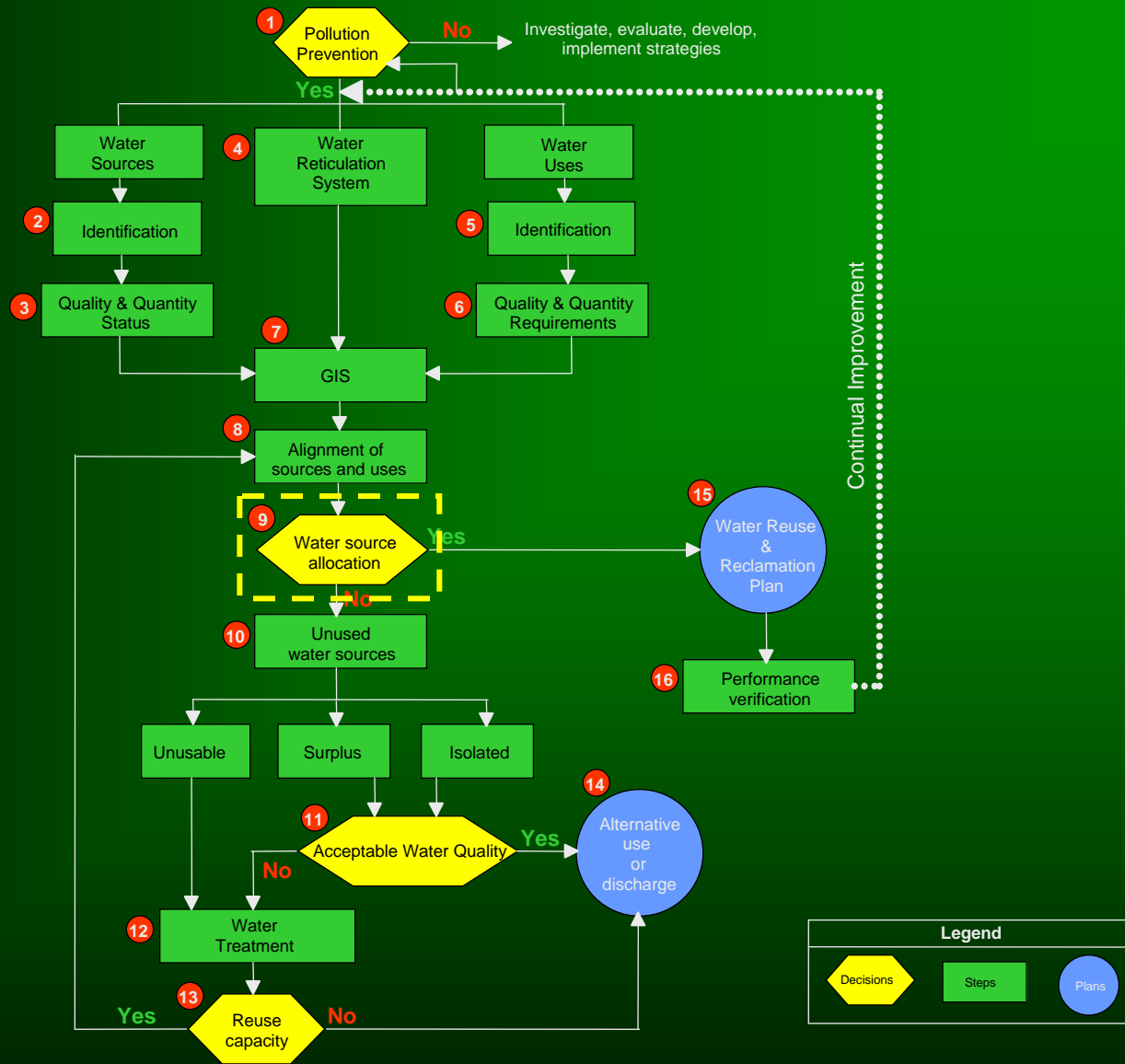


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# Process to develop WRRP





## Step 9: Water source allocation

### *Purpose:*

To determine whether all water sources have been allocated for reuse.

### *Decision:*

- If at this point in time all water sources have been allocated to a specific water use, i.e. all recycled water has been reused; the mine can complete its Water Reuse and Reclamation Plan (Step 15).
- If however this is not the case, and there is still surplus water that has not been allocated for reuse, proceed to Step 10.

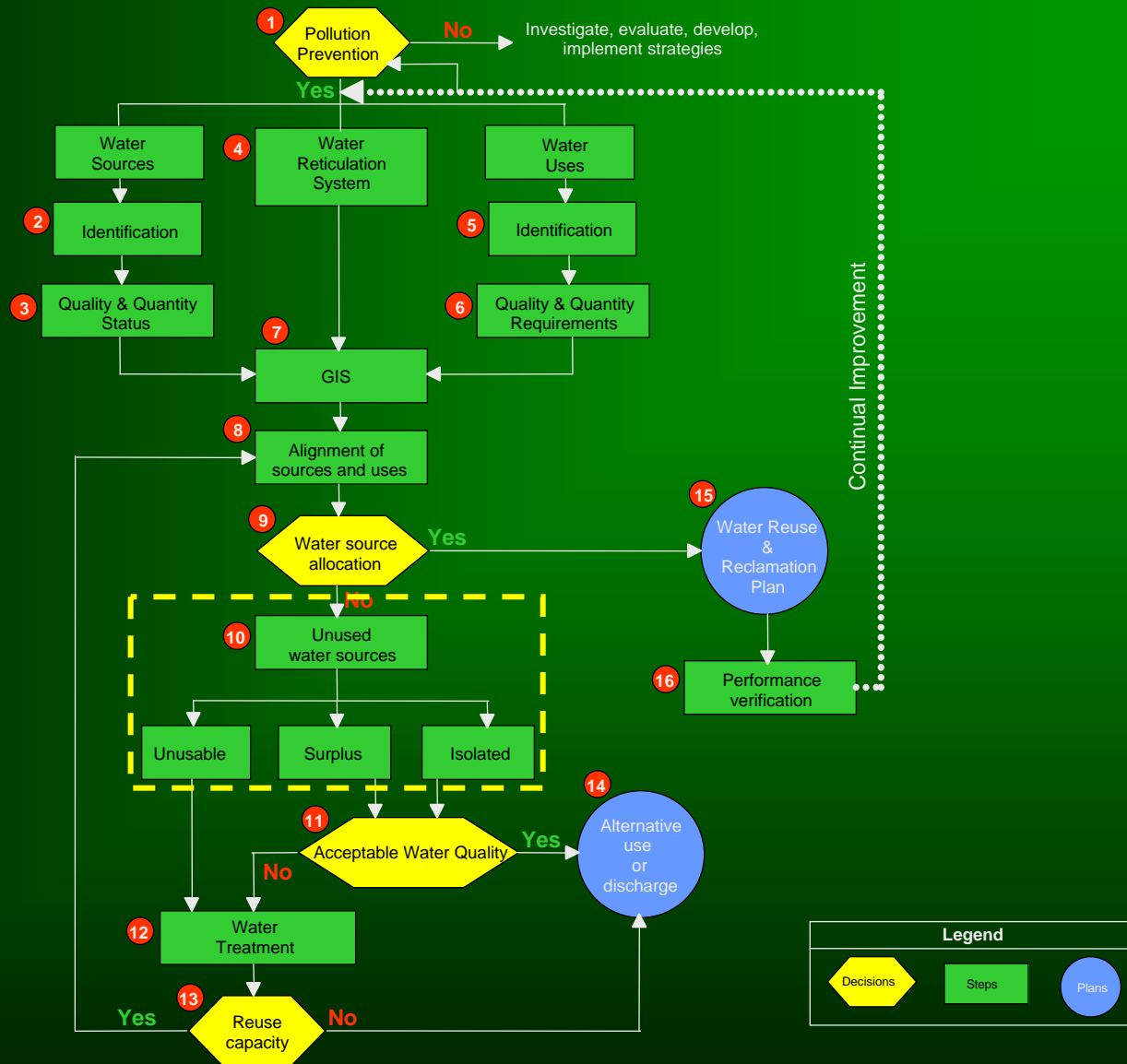


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# Process to develop WRRP





# Step 10: Define unused water sources

## *Purpose:*

To define the unused water sources, i.e. reason for not being allocated to a specific water use during Step 8.

## *Method:*

- Categorise the unused water in terms of the reason for not being allocated to a specific water use for reuse. Generally the main reasons for not being allocated are:
  - Water source is of too poor quality for reuse by any of the identified mine water uses.
  - There is a surplus of water, i.e. more water generated in the process than what could be reused.
  - Water source is either too small or isolated to be incorporated into the water reticulation system.
- In the case of unusable water due to water quality constraints, proceed directly to Step 12. In the case of the other reasons, proceed to Step 11.

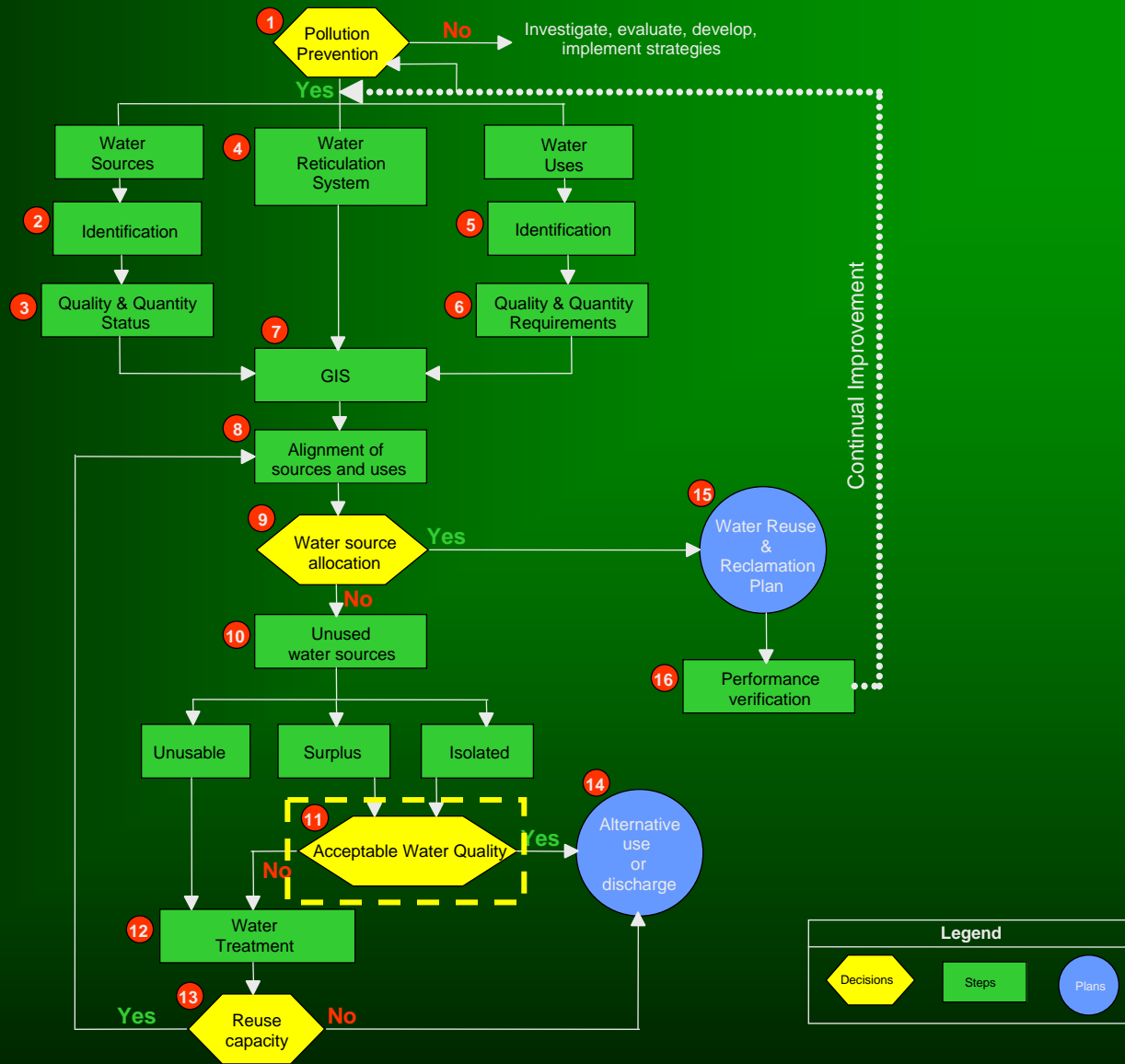


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# Process to develop WRRP





# Step 11: Acceptable water quality?

## *Purpose:*

To determine whether the unused water is of acceptable quality to allow alternative use or discharge/disposal.

## *Method:*

- Establish discharge limits and points in consultation with DWAF based on resource water quality objectives and downstream water user requirements.
- Evaluate the surplus and/or isolated water sources with respect to water quality.

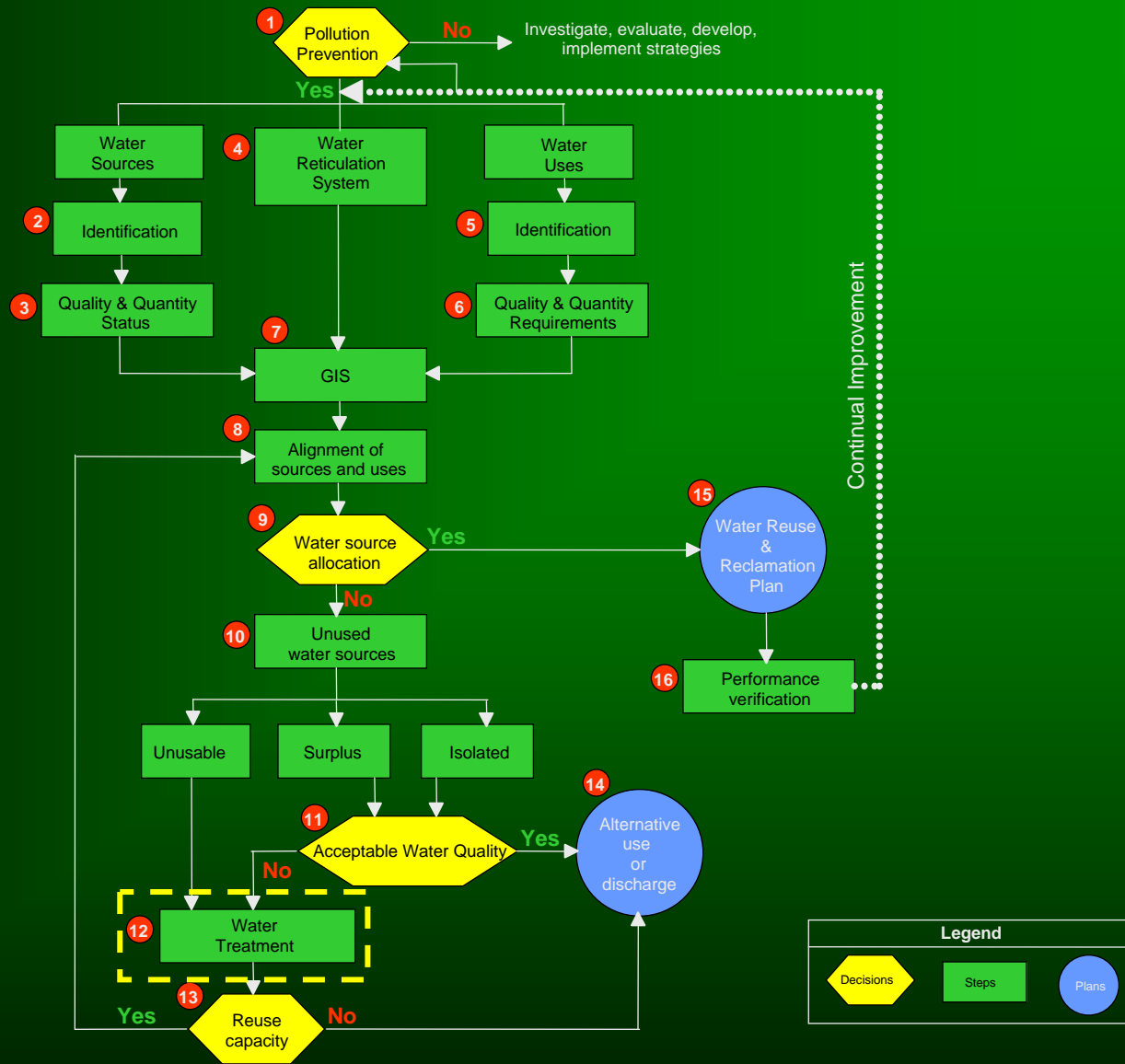


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# Process to develop WRRP





# Step 12: Water treatment

## *Purpose:*

To identify and investigate the relevant water treatment alternatives that are available based on target criteria (flow and quality requirements).

## *Method:*

- Consider water quality and quantity requirements for water use (Step 6).
- Consider contaminants causing adverse effects such as corrosion/scaling, affecting/impacting on product quality/yield and affecting/impacting process performance.
- Identify and investigate water treatment options – BPG H4.
- Determine process reliability. Consider whether the planned treatment process has been used for a similar situation/application..
- Evaluate all side streams from the treatment process to ensure that all costs and impacts are known (handling and disposing of sludge, etc).
- Establish whether it would be more appropriate to treat effluent streams simultaneously or separately based on characteristics/contaminants of concern.
- Evaluate type and optimal placement of treatment process to achieve the desired trade-off between performance, reliability, capital expenditure, operating costs, environmental impact and waste generated. May include laboratory/pilot plant testing to gather additional information.

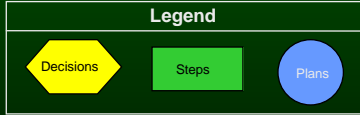
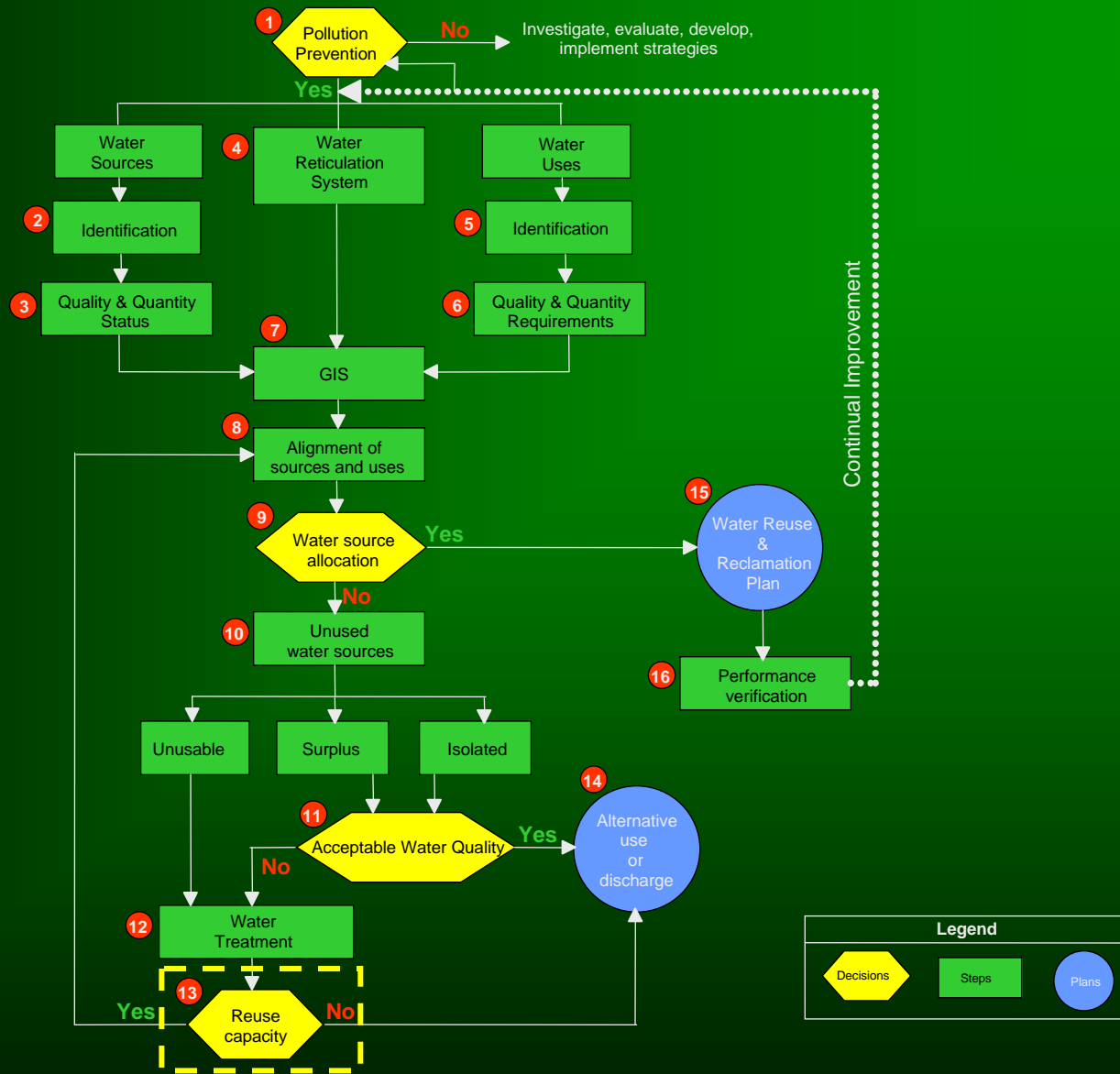


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# Process to develop WRRP





## Step 13: Determine reuse capacity after treatment

### *Purpose:*

To determine whether the treated water could be reused within the mine water system.

### *Decision:*

- If after treatment, the water has a reuse capacity based on the previous work, proceed back to Step 8 for alignment and allocation of the treated water.
- If the treated water cannot be reused within the mine water system, proceed to Step 14.

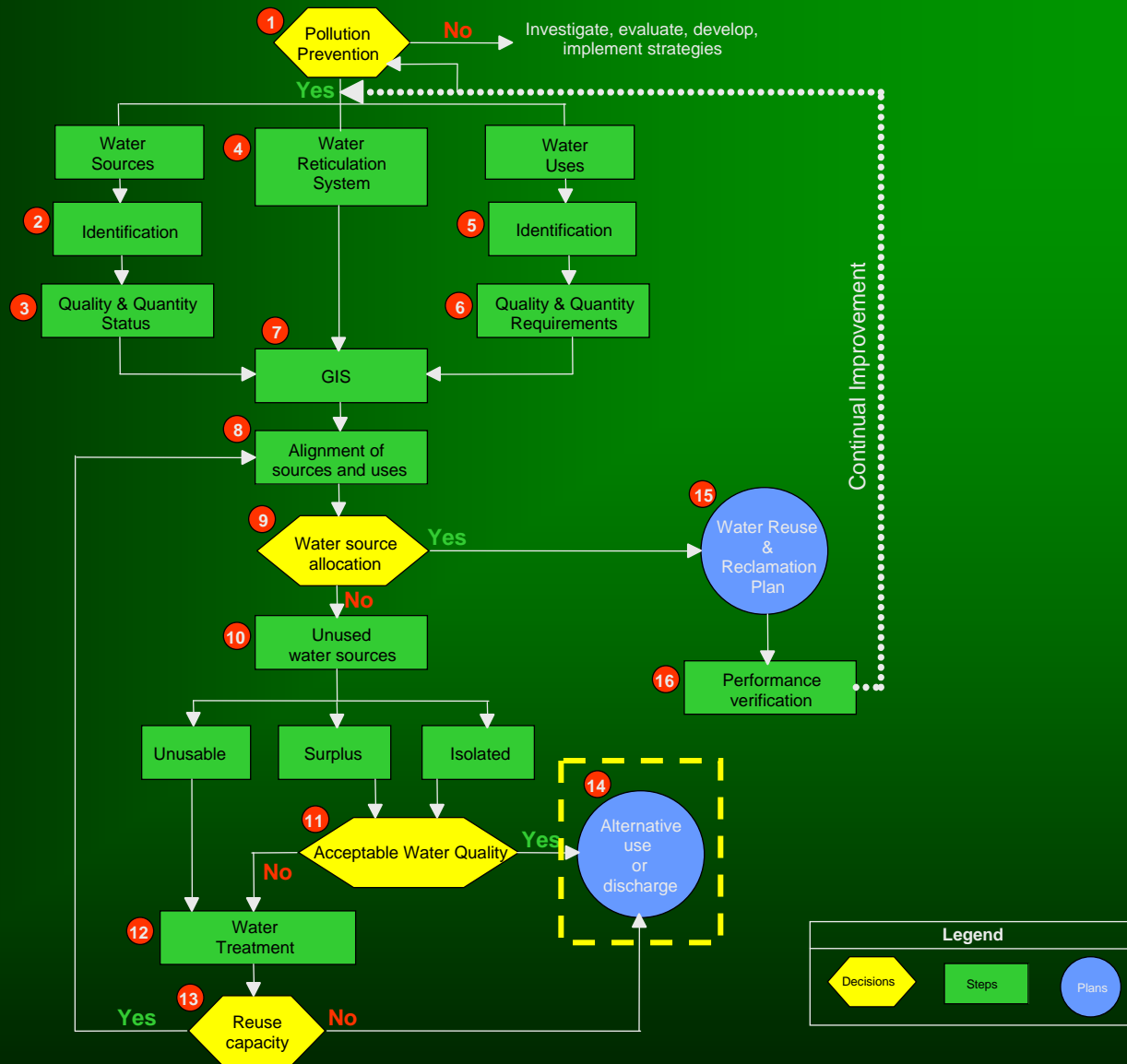


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# Process to develop WRRP





# Step 14: Alternative use or discharge

## *Purpose:*

To investigate alternative use or discharge options.

## *Method:*

- Two options can be considered if not all water can be reused in the system:
  - Identify alternative users (off-site or downstream) for this water.
  - Discharge or dispose to the environment with an appropriate water use licence/ authorisation.
- Evaluate the alternative options with respect to technical feasibility, cost, environmental impact and long-term sustainability.
- Determine the best practicable option based on specialist investigations (if necessary) and an environmental risk assessment.
- Discuss options with DWAF and obtain the necessary approval, whatever the final decision may be.

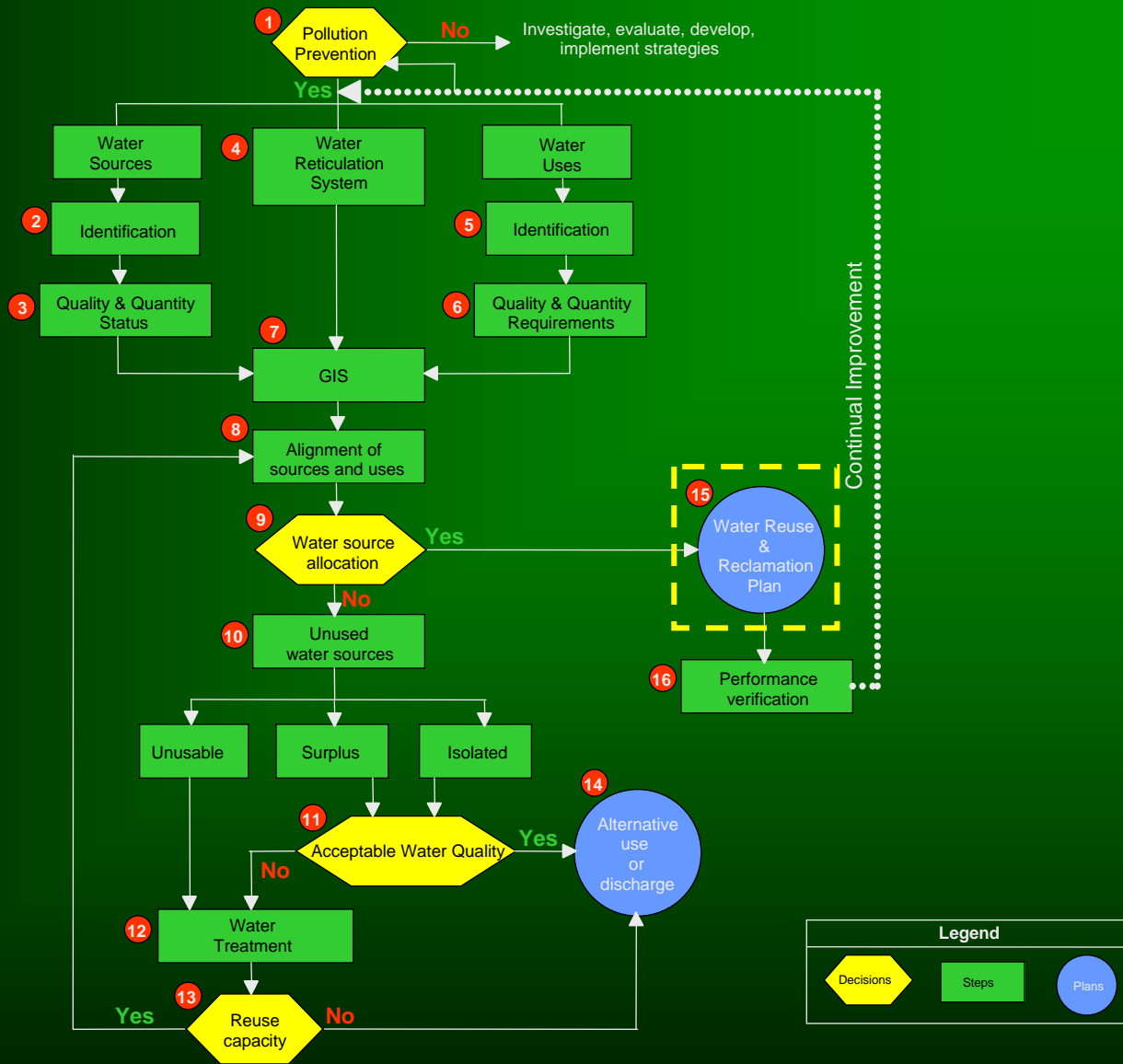


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# Process to develop WRRP





# Step 15: Water Reuse & Reclamation Plan

## *Purpose:*

To develop and implement the Water Reuse and Reclamation Plan.

## *Method:*

- After completion of the process described in Steps 1 to 14, the mine can complete its Water Reuse and Reclamation Plan.
- The methodology and process followed during the development of the plan must be described in detail.
- The reuse and reclamation plan should address the whole life of mine, including decommissioning and post-closure.
- The reuse and reclamation plan for a new mining operation will still be conceptual with long-term commitments and actions for closure.
- An existing operation, approaching closure, will have detailed plans for reuse and reclamation of excess water post closure.
- Develop an action plan for the implementation of the Water Reuse and Reclamation Plan.
- Develop measurable, quantifiable performance indicators for the Water Reuse and Reclamation Plan.
- Develop a performance verification plan to monitor the implementation process and verify the success thereof (Step 16).

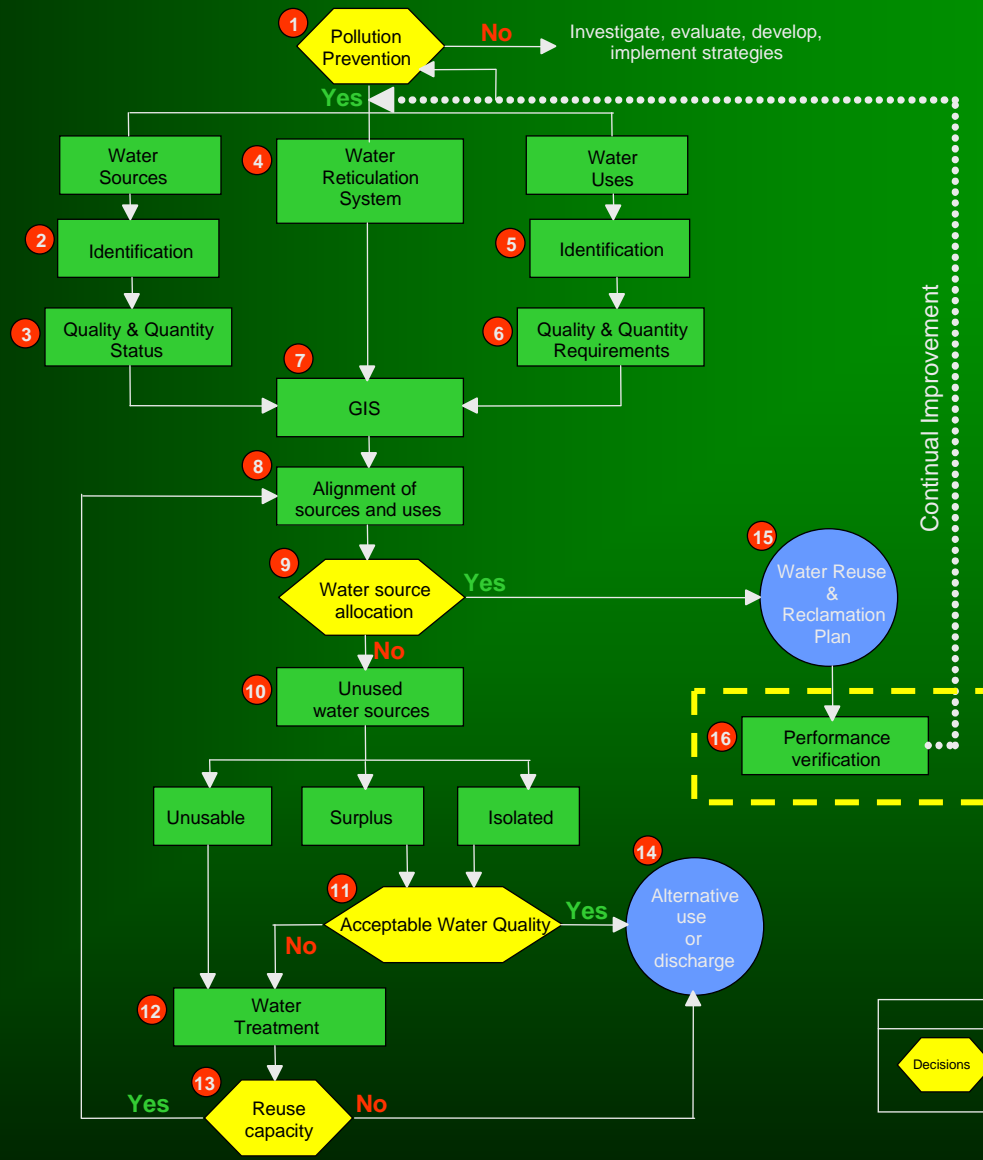


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# Process to develop WRRP





# Step 16: Performance verification

## *Purpose:*

To verify and review the success of the implementation process through its performance.

## *Method:*

- Implement a monitoring and auditing programme.
- Evaluate the performance of the Water Reuse and Reclamation Plan (comparison of actual and planned performance based on performance indicators).
- Verify and review plan regularly, especially if any changes in activities/processes have been made.
- Implement corrective actions, if necessary.
- Modify, revise or correct plan where necessary (corrective action requires going back into the loop). This is an iterative process to ensure conditions improve.



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# Legal & regulatory role of water reuse & reclamation plan (WRRP)

- No legal or regulatory obligation to produce WRRP unless stipulated as WUL condition
- WRRP could be contained within EMP or WULA
- While mine may chose not to produce a WRRP, it must demonstrate that WRRP principles have been applied
- Mine that applies this BPG will be considered to have met DWAF's requirements



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# Main points to watch for

- Failure to optimise pollution prevention or minimisation, thereby reducing potential for water reuse
- Tendency of users (especially process plants) to use highest possible water quality instead of lowest
- Use of tailings facilities as sinks for contaminants and excess water



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