

**OTT Pluvio Precipitation Gauge
Field Protocols**

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Prepared by:

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Document Status: This document will be periodically updated as new field protocols are developed or in some cases, the procedures may be updated with new information and science. Each individual protocol includes the date of release to allow updated versions to be identified in the future.

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1.0 INTRODUCTION

This document contains field protocols and methods for the measurement of precipitation using the OTT Pluvio precipitation gauge (OTT Hydromet, 1995) (OTT Hydromet, n.d.) in Alberta. These protocols are important to ensure that data are collected consistently and the data obtained are accurate and scientifically sound. This information is critical for flood forecasting and water supply, the accurate prediction of runoff, long-term hydrological analysis, agricultural insurance assessment, and to assist in the operation of reservoirs and hydroelectric facilities in Alberta.

The following procedures and instructions provide default processes for precipitation collection using the Pluvio gauge conducted within the Province of Alberta. In general, this method is the preferred means of obtaining an accurate collection of cumulative year-round precipitation which serves as an indicator for larger geographical areas. Consistency in both collection and methodology is critical to ensure integrity of long-term databases, and most critically for near-real-time analysis of precipitation amounts and intensity. Errors in measurement affect not only recent and current records, but also the statistical analyses of historical data and trend analyses.

This document is the first standard set of protocols to be used by all staff in Alberta Environment and Parks (AEP) when measuring precipitation using the Pluvio gauge. It outlines the procedures used by AEP in their programs. The protocols in this document are considered to be the best practices for this type of data collected in Alberta. However, this is a living document, and as new technologies and techniques are developed, they will be evaluated and may be included in future versions of these protocols. Each protocol consists of a brief description of purpose, general background on the techniques employed, the type equipment required, and a step-by-step procedure to collect and verify the results.

It should be noted that this manual focuses on field procedures and it does not cover the design of field programs or selection of site locations. Selection of new or alternate sampling locations should be done in consultation with experienced staff and the scientific professionals involved in interpreting, analyzing, and reporting on the data. Proper interpretation of special circumstances and advanced troubleshooting is a skill that can only be developed with experience.

No official formal standard operating procedure (SOP) for the measurement of precipitation using the OTT Pluvio precipitation gauge has been written by the Government of Alberta. Most knowledge has been passed on through demonstration, collaboration, and mentorship. Guidance was gained from the equipment manuals, as well as informal training from the vendor and OTT staff. Additional information can be found at www.ott.com.

2.0 MEASURING PRECIPITATION WITH THE PLUVIO GAUGE: PROTOCOLS

It should be noted that there are two versions of the OTT Pluvio precipitation gauge currently employed in Alberta. The Pluvio I, which was first installed in Alberta in 2001 and is the most common, is capable of holding 1000 mm of liquid precipitation. The Pluvio II (Pluvio²) is an updated version, first employed in Alberta in 2006. The Pluvio² comes in two models, one capable of holding 750 mm of liquid precipitation, the other 1500 mm. There are differences in construction and operation of each, and they are discussed separately.

2.1 General Instruction

Purpose

To obtain accurate and consistent measurement of precipitation in liquid or solid form 24 hours a day, 365 days a year.

Description of OTT Pluvio Gauge

Proper siting/location of the gauge will not be discussed in this document. The gauge should be mounted on a solid, level base extending up at least one meter above the maximum expected snow depth. An alter shield is also employed to help correct for wind drift of precipitation, and should be mounted with the top extending 3 cm above the top of the gauge orifice (Figure 1a). The gauge is powered externally by 12-volt batteries.

The Pluvio I (Figure 1b) utilizes an electronic weighing cell which is individual temperature rated. The frictionless moving elements of the device result in an extremely accurate measurement of weight (a resolution of 0.2 g), which can then either be converted into electrical pulses (which can be counted by the data logger) or into a Serial Digital Interface at 1200 baud (SDI-12) signal. The standard AEP configuration is pulse output in units of 0.1 mm per pulse. Hardware and software filters provide dampening for the effects of wind and other disturbance of the field setup.

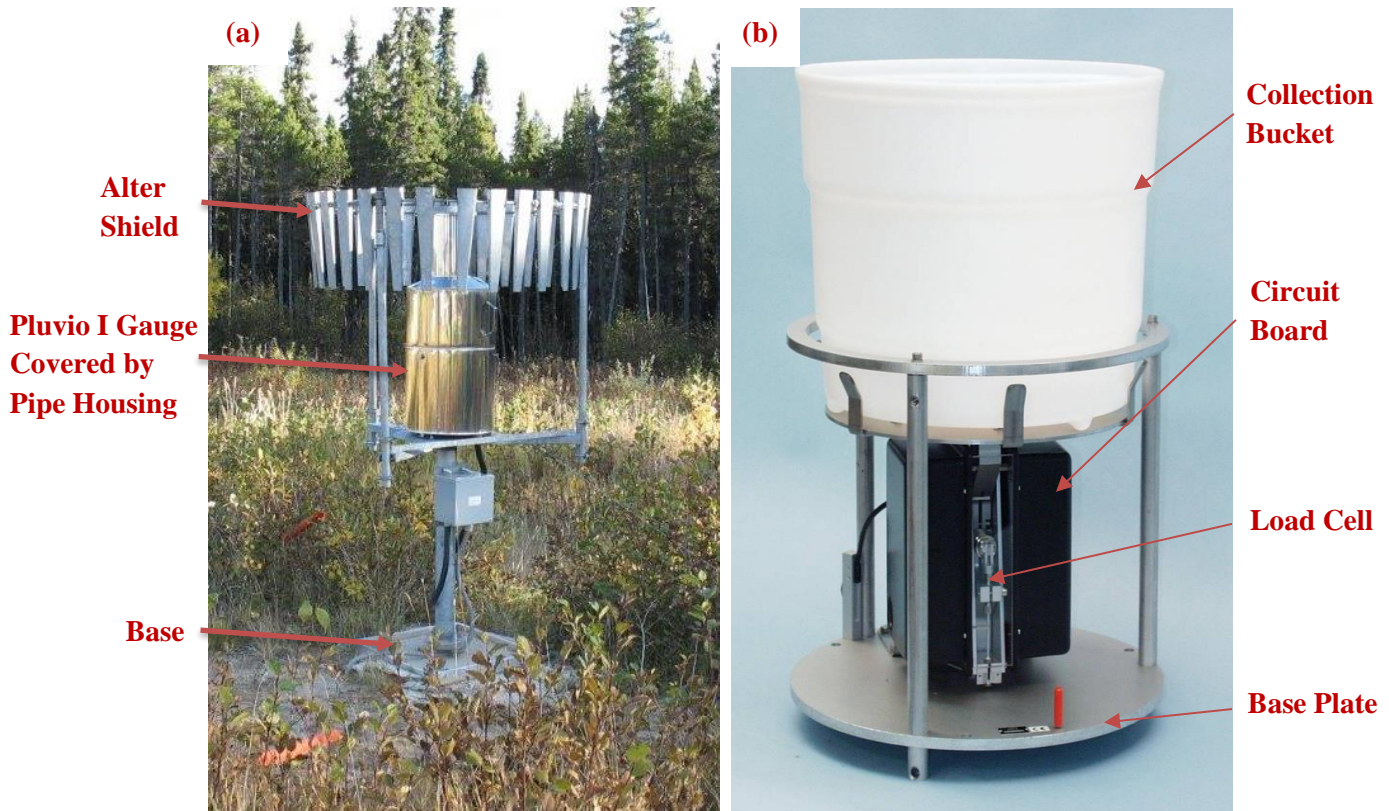


Figure 1. (a) Field Setup and (b) Key Components of Pluvio I Gauge

The Pluvio² (Figure 2) uses a sealed single load cell and a software filter. This gauge is capable of World Meteorological Organization (WMO) standard measurements of intensity and accumulation due to more sophisticated electronics and algorithms, where the dampening delay in the Pluvio I did not allow it to meet these guidelines.

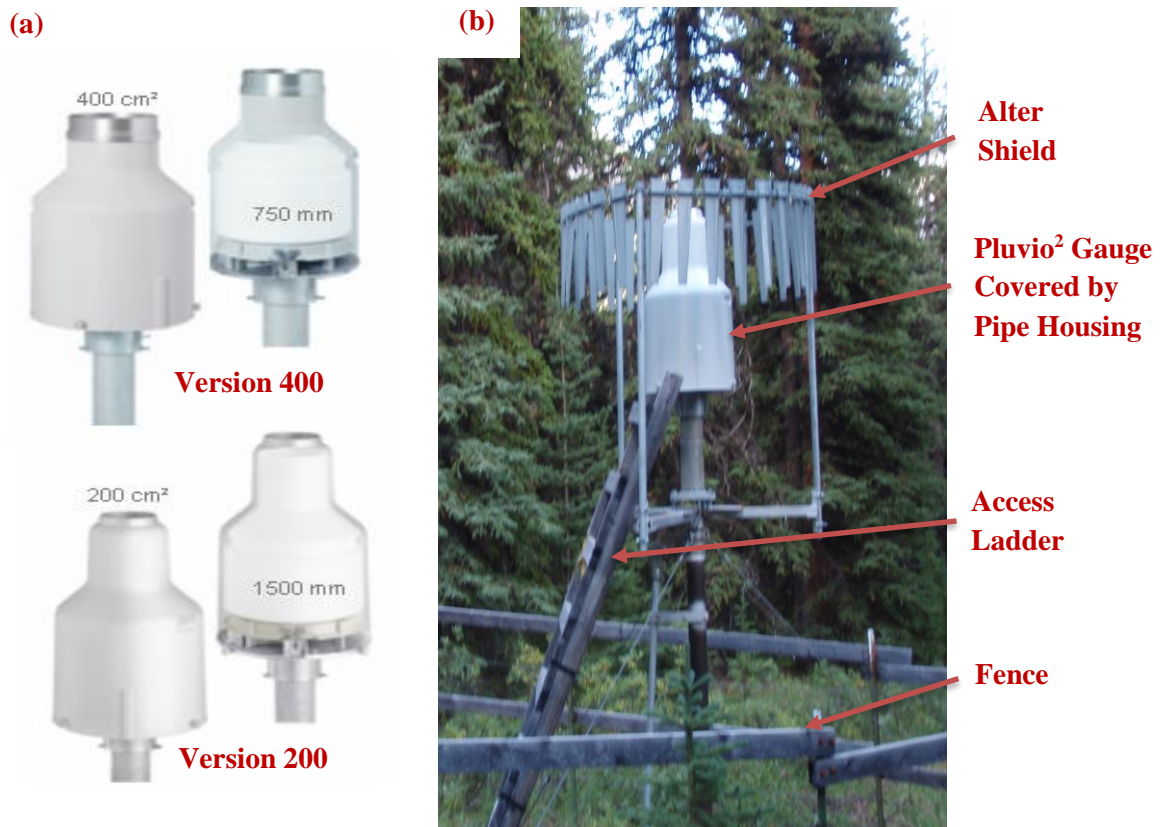


Figure 2. (a) Two Versions of Pluvio² Gauge and (b) Field Setup. Version 400: 400 cm² for bucket orifice opening and 750 mm for recording capacity; Version 200: 200 cm² for bucket orifice opening and 1500 mm for recording capacity.

Either gauge is “recharged” with ethylene glycol to melt solid precipitation and prevent freezing.

Equipment

- Pluvio precipitation gauge
- Proper mounting base and alter shield
- Ladder to access gauge (if required)
- Wrenches to adjust gauge level
- Collection vessel and funnel for waste precipitation and debris (a jerry can works well)
- Ethylene glycol for recharge material
- Paper towel and cleaner for cleaning collection bucket and gauge housing
- 200 mL graduated cylinder and water for quick calibration check
- Set of four certified 5 kg weights for in-depth full range calibration check (Pluvio I)
- USB cable, Pluvio² software, and 2 – 5 kg certified weights for Guided Accuracy Check (Pluvio²)

Procedures

A) 200 mL Quick Calibration Check

In addition to being rapid, the advantage of this method is that it does not need to start from zero reading every time. It will be performed in several different areas in the scale of the device over time, due to the natural variation in accumulated amounts of precipitation in the gauge.

- Note your current precipitation reading on arrival, and download data.
- Accurately measure 200 mL of water into a graduated cylinder, and add it to the gauge. For the Pluvio I, it can be added instantaneously. But for the Pluvio², it has to be added very slowly (no greater than approx. 12 mm of increase in weight within 6 seconds).
- Monitor the readings on the data logger. Due to the filtering algorithms, it could take several minutes for the completed measurement cycle.
- Your end reading should be 10 mm higher than your start reading. Deviations greater than 0.1 mm indicate either an inaccuracy in the water measurement, gauge being out of level, or a need for a full-range calibration (Pluvio I) or Guided Accuracy test (Pluvio²).

B) Recharging of Gauge

- Carefully remove the cover (pipe housing) from the gauge.
- Gently remove collection bucket from weighing mechanism. **Use extreme caution!** Dropping a full bucket back down on the weighing base could result in the gauge being damaged beyond repair.
- Empty collection bucket into jerry can using funnel to eliminate spillage.
- Thoroughly clean bucket, pipe housing, and inside of gauge with paper towels and commercially available environmentally friendly spray cleaner.
- Verify levelness of gauge with a bullseye bubble level mounted on the base plate. Even very small deviations of bubble from the centre of the level's circle can result in inaccuracies. Adjust using leveling nuts on base (Pluvio I) or mounting collar (Pluvio²).
- Inspect inside of weighing mechanism for debris (e.g. spider webs) and remove debris.
- Inspect transverse bars (Pluvio I) for any bends or distortion. If bent, the device should be sent to the vendor in Vancouver or the factory in Germany for servicing.
- Replace bucket on base and add appropriate recharge: 4 L of ethylene glycol for the Pluvio I, and 6 L of ethylene glycol for the Pluvio².
- The data logger should then be reset to 200.0 mm for the Pluvio I, and 300.0 mm for the Pluvio². Allow the gauge to “rest” approximately 7 minutes after recharging before placing the pipe housing back on. Continue to monitor readings for at least 15 minutes to ensure it remains at the reset value.
- For the Pluvio², ensure the top flange on the orifice is centered, and not pressing down on the collection bucket below.

3.0 WEIGHT CALIBRATION CHECKS

Purpose

This is to ensure the accuracy of the weighing cell in the Pluvio used to determine precipitation. Any deviation outside manufacturer's specifications would require the unit to be returned to the factory (Germany) for repair.

General

For a variety of reasons, it may be necessary to do a more in-depth calibration on the Pluvio gauge. This may be triggered by observation of repeated variations over 2 % from the "200 mL Quick Calibration Check", erratic or suspicious readings, or just as good quality control practice.

Equipment

- Certified 5 kg stainless steel weights
- Ring or polyvinyl chloride (PVC) cap to protect bullseye on Pluvio I
- Laptop computer for monitoring readings on the data logger

3.1 Procedure for Pluvio I Full-Range Weight Check

1. Remove the pipe housing and bucket, and perform any needed maintenance, cleaning, etc.
2. Ensure the unit is completely level using the bullseye level on the top of the bucket plate. The Pluvio should have been mounted to the base using 4-inch threaded rods to allow for level adjustment.
3. Allow the unit to stand with the pipe housing switch open for at least **7 minutes**, which allows the internal filter and buffer to clear. Place a sturdy base (a 4-inch PVC cap works well) over the level bubble, centering it on the bucket plate. Close the pipe housing contact switch with a binder clip or rubber grommet.
4. **Close the contact switch with a spring clip or other device and allow the unit to stand untouched at least 7 minutes once again.** If you do not do this, the unit **will not** register the weight you place on it!
5. Set your precipitation reading to 0.0 on the data logger.
6. After 7 minutes, add your first 5 kg weight. **Weights must always be handled with clean gloves (cotton or latex).** This should result in a reading equivalent to 250.0 mm of precipitation. Due to the filtering and signal processing onboard the Pluvio, it will take **8-16 minutes** for the full amount of the weight to be measured. The maximum the Pluvio can output is 300 pulses, or 30.0 mm of precipitation, in one minute.
7. Keep scanning your data logger output to ensure the unit is responding. Once you are certain the final reading has stabilized, make note of it.
8. If you are doing a full calibration, you can now add your next 5 kg weight and repeat steps 6 and 7, but you do not need to wait the additional 7 minutes in between. Once again, it will take 8-16 minutes to output the full 5 kg equivalent (250.0 mm).
9. A full range calibration requires four 5 kg weights, and approximately one hour to complete. Be certain that when adding weights that they are centered and stable, since the effect of 20 kg crashing down on top of the weighing mechanism could be catastrophic to your gauge!
10. Once calibration is complete and documented, carefully remove the weights and open the pipe housing switch. You can then replace the bucket and add your recharge. Be sure to reset your precipitation value to the start reading (typically 200.0 mm), and make note of any erroneous values that may have been logged during the calibration procedure. Allow the gauge to "rest" approximately 7 minutes after recharging before placing the pipe housing back on. Continue to monitor readings for at least 15 minutes to ensure it remains at the reset value.

Table 1. Example of Full Range Calibration Record

Site: Christina Lake

Date: Oct 10/07

Pluvio S/N: 168485

Time (MST)	Weight Added (kg)	Weight Number	Result (mm)	Percent Deviation
15:26	5	10	250.7	0.3
15:41	5	12	500.7	0.1
15:55	5	9	751.3	0.2
16:10	5	11	1001.6	0.2

WHAT IF THE READINGS FALL OUTSIDE OF PERMITTED TOLERANCE

Published accuracy of the gauge permits deviations up to 1 %. If your results are outside this tolerance, first ensure your gauge is **absolutely level**. Even very minor deviance from horizontal level can skew the results. Inspect the weighing mechanism for spider webs or condensation. Repeat the test. If results are still outside the 1 % tolerance, the gauge will need to be sent back to the manufacturer for repair and recalibration.

MAINTENANCE OF CALIBRATION WEIGHTS

It is also important to remember that each calibration weight comes with its own calibration record and certification. This alone could explain some of the deviation in the measured values. It is crucial to keep these weights clean and dry. Cleaning should be done with a soft, lint-free cloth, or if absolutely required, a very small amount of ethyl alcohol. A 3-year recalibration cycle has been proposed for these weights.

3.2 Procedure for Pluvio² Guided Accuracy Check

This process is performed with software, which, as intimated, guides you through the process. Just follow the steps on screen, and in a few minutes you should have a detailed result of your gauge’s performance. Basic outline is as follows:

- Connect to the Pluvio using a Type A to Type B USB cable.
- Open the Pluvio² software, connect to the Pluvio², and select Tools-Guided accuracy test.
- When prompted, place the first 5 kg weight on the base and allow it to measure.
- Add the second weight when prompted, and allow it to complete the measurements.
- A detailed result of your calibration and a pass/fail will be displayed. This can then be logged for inclusion with your station records.

3.3 Other Means of Checking Output

Since approximately 2016, it has not been a standard AEP practice to “cap” the recharge with VOLTESSO™ oil. If there is an operational requirement or a gauge performance issue that dictates the need to check the total volume collected in the bucket, a portion of ethylene glycol (0.5 L) in the recharge can be replaced with the same amount of VOLTESSO™ oil to prevent evaporation of the contents in the bucket. Since either Pluvio gauge is an accumulated total of precipitation, if you know the recharge volume added initially (which makes it necessary to carefully measure the recharge volume), you can then calculate the volume of precipitation collected since that time. This could be useful as an overall check on gauge performance, or if communication with the data logger is lost due to power issues or some other cause. Total cumulative precipitation can still be derived though there will be no associated time stamp. As an example, in the Pluvio I each 20 mL of volume equals 1 mm of precipitation. Therefore, if you had 14,400 mL collected which minus the 4000 mL recharge would equal 10,400 mL. A total of 520.0 mm of accumulated precipitation is then calculated after dividing 10,400 mL by 20 mL/mm ratio.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

- OTT Hydromet (1995). *OTT Pluvio Raingauge Operating Instructions*.
- OTT Hydromet (n.d.). *OTT Pluvio² Precipitation Gauge Operating Instructions*. Available at <http://www.ott.com/en-us/products/download/operating-instructions-precipitation-gauge-ott-pluvio2-1/> (Accessed: 8 June 2018)