



Dams Safety and Hydraulic Structure





OVERVIEW

Leading environmental private company in Brazil



Since 2017, BRK is **BROOKFIELD's** sanitation platform in Brazil



Leading environmental private company in Brazil in **WATER & WASTEWATER**



Geographically **DIVERSIFIED** portfolio with **23 SPES**, mitigating revenue concentration & hydrological risks

Diversified **CONTRACTUAL** models



15 mm
inhabitants



12
states



185
municipalities



5.888
Employees¹

R\$ 2.1 Bn

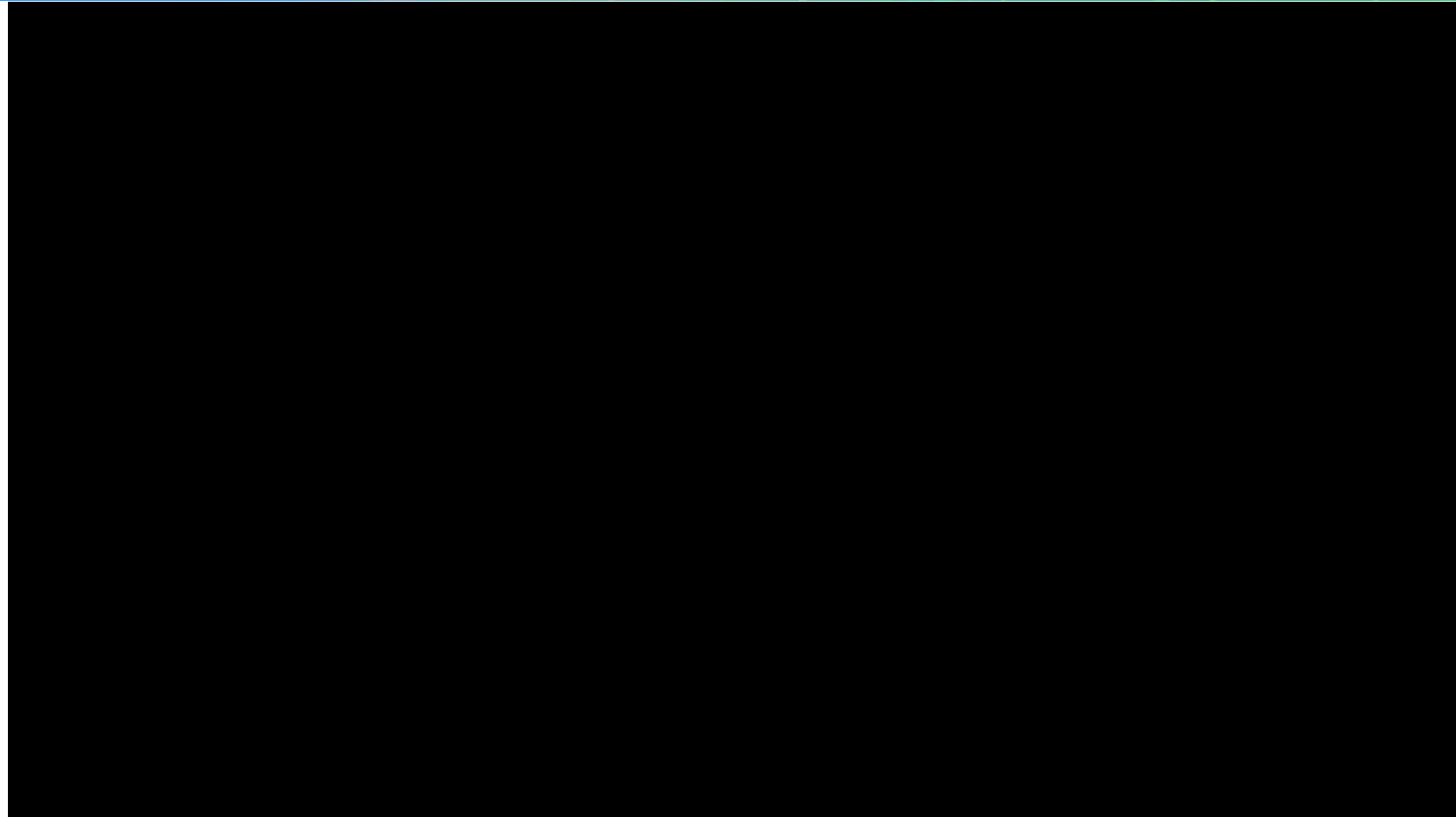
Net Operating Revenue² 2018
CAGR 2010-2018: 33%

R\$ 0.8 Bn

EBITDA² 2018
CAGR 2010-2018: 34%



Note: Base Dec/2018
/1 Include interns
/2 100% SPES + 50% AP5







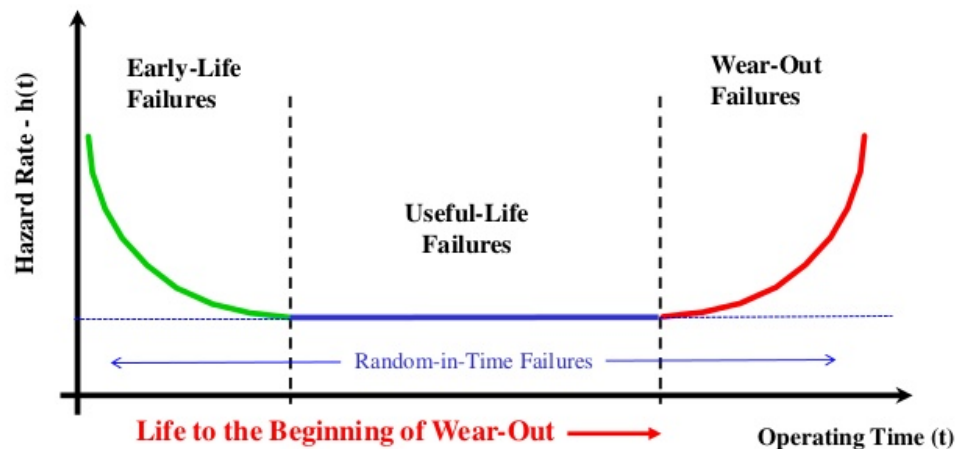
BRK has 32 dams for raw water storage and 85 sewage treatment ponds, spread from north to south of Brazil.





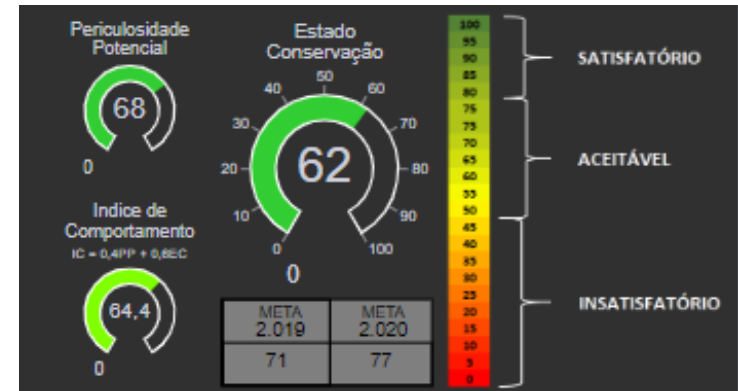
We received structures with advanced age of operation. New structures have a high rate of damage. Throughout useful-life the risk is less. Valuable risk grows near the end of useful life of the structure.

Bathtub Curve





Every year, a qualitative risk assessment is performed, in which notes for the State of Conservation (cracks, infiltrations, maintenance failures, etc.) and Potential Hazard (height, volume, population downstream, etc.) are given, resulting in Behavior Index, which ranges from 0 to 100. This index assist senior management in decision-making regarding investments and intervention priority.



CLASSIFICATI ON BANDS	BEHAVIOR INDEX	TOTAL
	SATISFACTOR Y	≥ 80
	ACCEPTABLE	$80 < BI < 50$
	UNSATISFACT ORY	≤ 50



After intense rains, an overtopping occurred due to sudden elevation in the reservoir level, putting at risk the stability of the structures, which could lead to its rupture.



Overtopping occurred in 02/09/2018



In order to improve the levels of security and monitoring of these structures, there was a need to implement a system to provide information for operational areas and made available to Corporate Engineering with headquarters in São Paulo.





The PI System provided quick access to the following information:

- Cadastral data of all structures (height, capacity, year of construction, data of the person in charge, etc.)
- Control of maximum and minimum operating levels
- Control of Attention, Alert and Emergency Levels
- Database generation and graphics production
- Storing rainfall data
- Displays the Criticality Index information
- Inserting data using mobile, tablet and computer



OSIsoft Products

Data Input

PI Manual Logger



PI DataLink



Treatment

PI Data Archive



PI AF Server



Visualization

PI Notifications



PI Vision





iePI Manual Logger

- Manual input of most important structure data
- Inserting data using mobile, tablet and computer

PI Manual Logger
Online

Dados de Monitoramento - Cristalândia Barragem Campeira: March 16, 2019 11:00:00 AM
[Switch to individual data entry](#)

Expand All Collapse All

↑ Group ×

	Group	Description	Value	Previous	UOM	Comment	Timestamp	Limits
Group: Descarregador de Fundo								
▶	Descarregador de Fundo	Descarregador de Fundo					March 16, 2019 11:00:00 AM	
▶	Descarregador de Fundo	Numero de Voltas da Abertura (0 = Fechado)					March 16, 2019 11:00:00 AM	
▶	Descarregador de Fundo	Porcentagem de Abertura					March 16, 2019 11:00:00 AM	
Group: Nível								
▶	Nível	Nível da barragem	<input type="text" value="x"/>				March 16, 2019 11:00:00 AM	Hi-H(8)
Group: Pluviometria								
▶	Pluviometria	Pluviometria					March 16, 2019 11:00:00 AM	
Group: Vertedor								
▶	Vertedor	Vertendo?					March 16, 2019 11:00:00 AM	



PI AF

- Cadastral data of all structures (height, capacity, year of construction, data of the person in charge etc)

\\FOZ-PIA01-DC\Ambiental - PI System Explorer

File Search View Go Tools Help

Database Query Date Back Check In Refresh New Element New Attribute Search Elements

Elements

- Elementos
 - Ambiental
 - Água e Esgoto
 - Água
 - Cachoeiro de Itapemirim
 - Captação
 - Distribuição
 - Estruturas Hidráulicas
 - Barragem
 - PCH Ilha da Luz
 - Operações
 - Produção
 - Limera
 - Mairinque
 - Maranhão
 - Porto Ferreira
 - Saneatins
 - Santa Gertrudes
 - Sumaré
 - Uruguaiana
 - Esgoto
 - Industria
 - Interface IO Rate
 - Resíduos

Element Searches

Elements

Event Frames

Library

Unit of Measure

Contacts

Management

61 Attributes

PCH Ilha da Luz

General Child Elements Attributes Ports Analyses Notification Rules Version

Excluded attributes are hidden.

Group by: ☒ Category ☐ Template

Filter

Name	Value
Nível Bruto	Configure
Periculosidade Potencial	60
Periculosidade Potencial - Classificação	significativa
Pluviometria	0 mm
PNISB aplicável	True
Porcentagem de Abertura	0 %
Projeto Atualizado	True
Soleira do Vertedor	1,5 m
Status	-
Telefone	
Termo de Construção	1930
Vazão Máxima	64 m³/s
Vazão Média	0 m³/s
Vertedor	Não
Volume	No Data
Volume Máximo	0
Volume Morto	0
Órgão Fiscalizador	ANEEL
Category: Barragens - Classificação ANA	
Category de Risco	32

Value: True
Time Stamp: 01/01/1970 00:00:00
Quality: Good



PI AF - Analyses

- The system compares the level with defined ranges and set the operational condition.
- Calculate the Behavior Index

Elements

- Ambiental
 - Agua e Esgoto
 - Agua
 - Cachoeira de Itapemirim
 - Linara
 - Marmelo
 - Parati-Petropolis
 - Saneamento
 - Alameda do Tocantins
 - Alto Lindo
 - Alvorada
 - Araguaina
 - Araguari
 - Armação
 - Santa Gertrudes
 - Sumaré
 - União
 - Estações Hidráulicas
 - Barragem
 - Campeira
 - Barro Preto
 - Diamantina
 - Figueira
 - Ferreira de Aragui
 - Gurupi
 - Itaipava
 - Palmeiras
 - Palmeiras
 - Parati do Tocantins
 - Parati Nacional
 - Yngueira
 - Santa Gertrudes
 - Sumaré
 - União
 - Industria
 - Interface 3D Rate
 - Resíduos

Campeira

General	Child Elements	Attributes	Ports	Analysis	Notification Rules	Version
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Name	Barraagem Alerta					Backfilling
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Name	Barraagem Emergência					Backfilling
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Name	Classificação ANA segundo Dano Potencial Associado					Backfilling
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Name	Classificação da Barraagem - ANA					Backfilling
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Name	Classificação Estado					Backfilling
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Name	Classificação Periculosidade					Backfilling
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Name	Condição Operacional					Backfilling
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Name	Índice de Comportamento					Backfilling
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Name	Índice de Comportamento Classificação					Backfilling
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Name	Notificação Condção Normal					Backfilling

Generation Mode: Explicit Trigger

Event Frame Template: Barraagens

Name	Expression	True for	Severity
Atual	TagVal('Condição Operacional', '')		
Anterior	Preval('Condição Operacional', '')		
Normalizacao	<code>if Atual = "Normal" and Anterior = "Emergencial" then 1 else 0</code>		
Start trigger	<code>Normalizacao = 1</code>	30 minutes	None

Functions

Insert functions into the expression

- All
- Accs
- And
- ArrayLength
- Ascii
- Asin
- Atn
- Atn2
- Aug
- Barfial
- Boo
- Bom
- Bonn
- Ceiling
- Abs(number x)

Return the absolute value of an integer or real number.
Example: Abs(-2.2) Returns 2.2

Advanced Event Frame Settings

Scheduling: ☒ Event-Triggered ☐ Periodic

Trigger on: ☐ Any Input

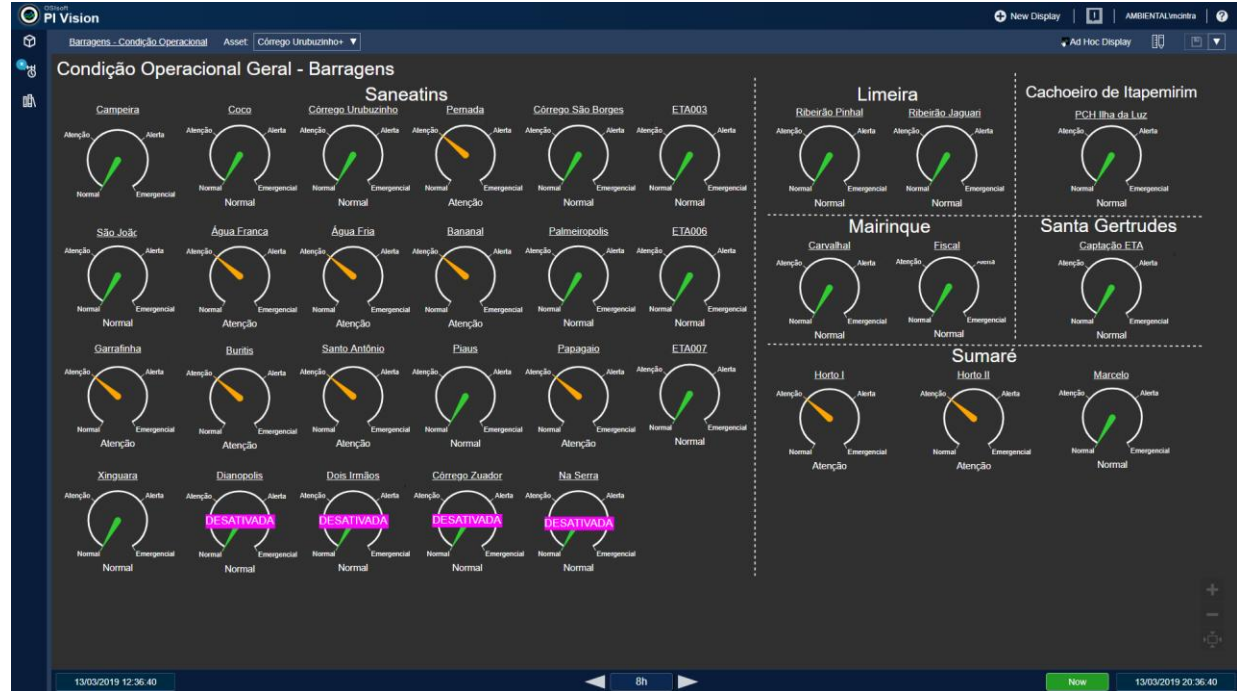
Campeira Modified: 11/03/2019 14:47:36 Ownsystem Version: 01/01/1970 00:00:00, Revision 15

Connected to the PI Analysis Service



PI Vision

- Overview of the operational condition of all dams and hydraulic structures
- Displays the Criticality Index information





PI Vision

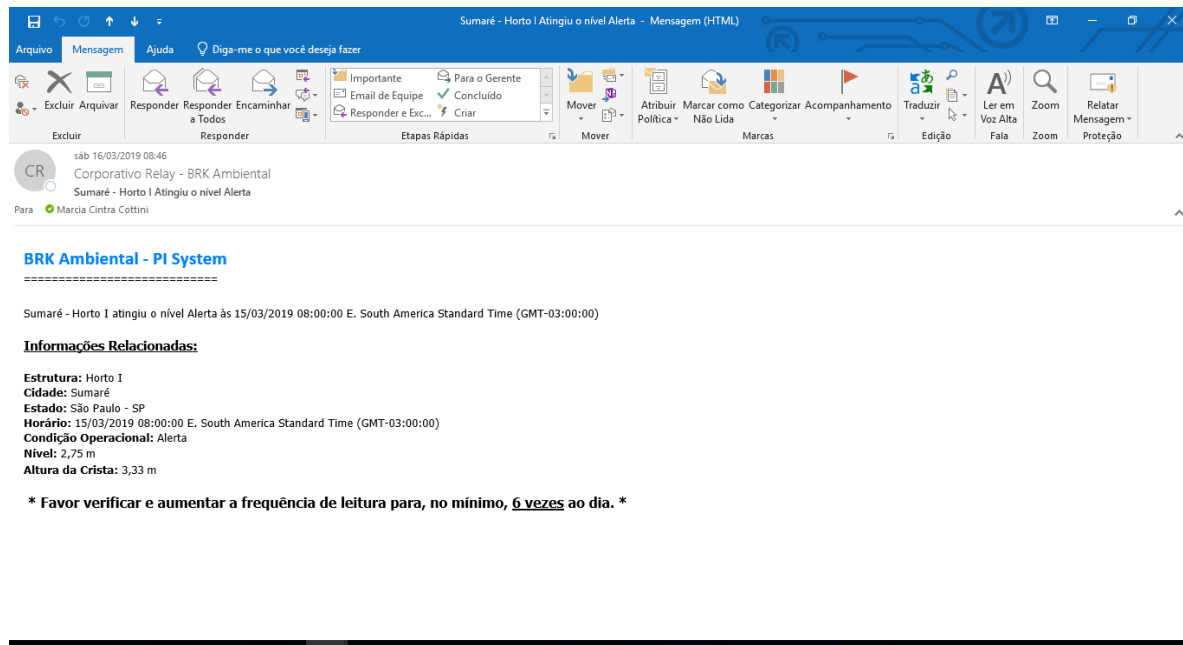
- It allows an analysis of the historical of the behavior of the structure supporting in the decision making.





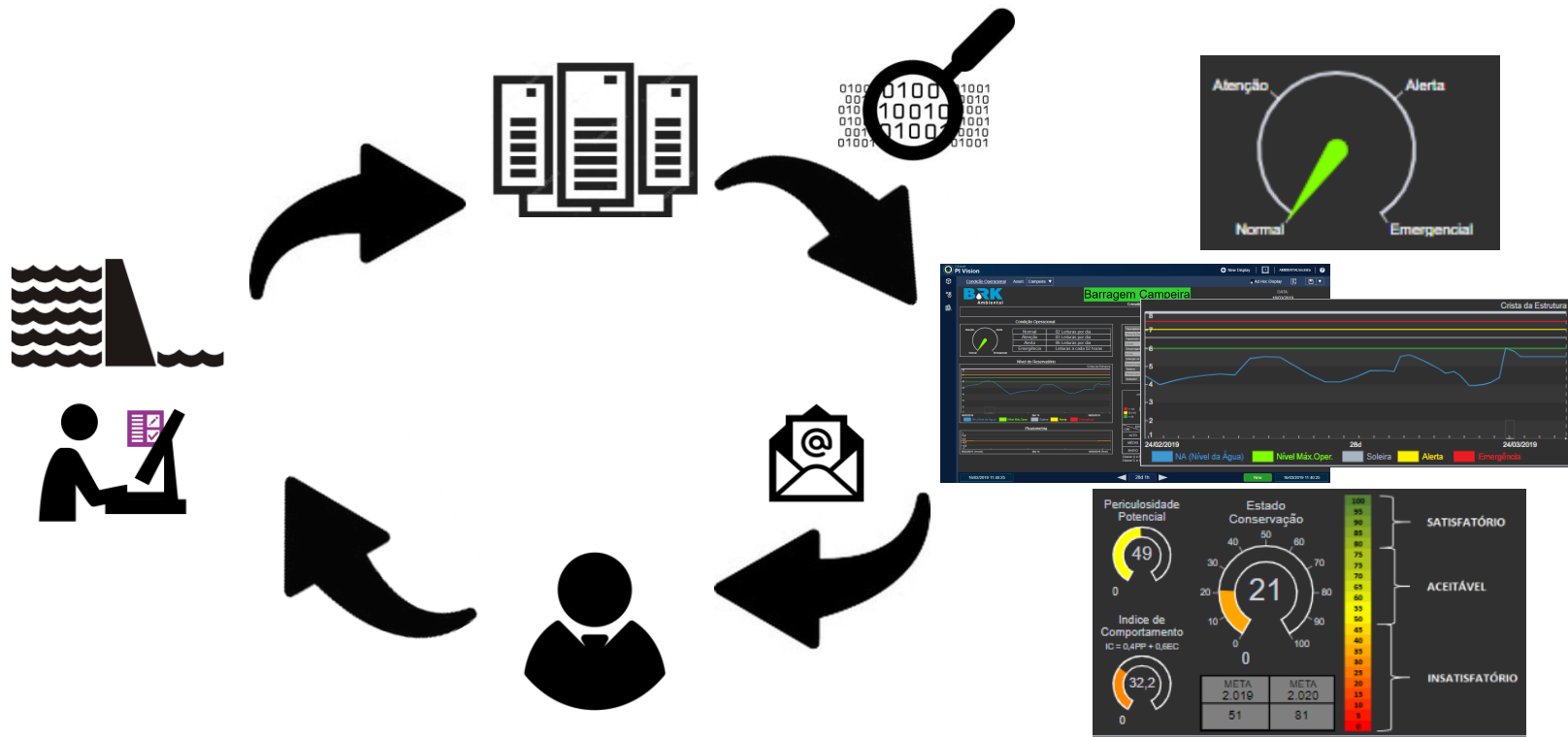
PI Notification

- The system compares the level with defined ranges and sends e-mail to responsible.
- When the emergency level is reached the directors receive the same communication and the crisis committee is activated.





Data Flow

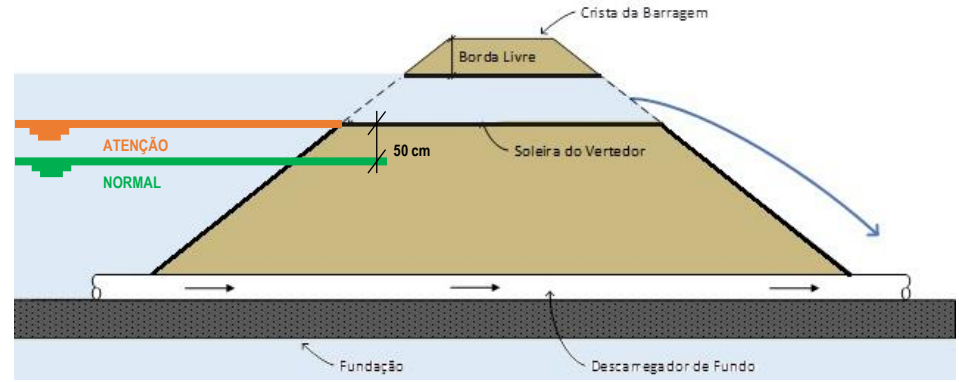




Operational Condition

Attention

- email operational and corporate team
- increases reading frequency
- check weather forecast

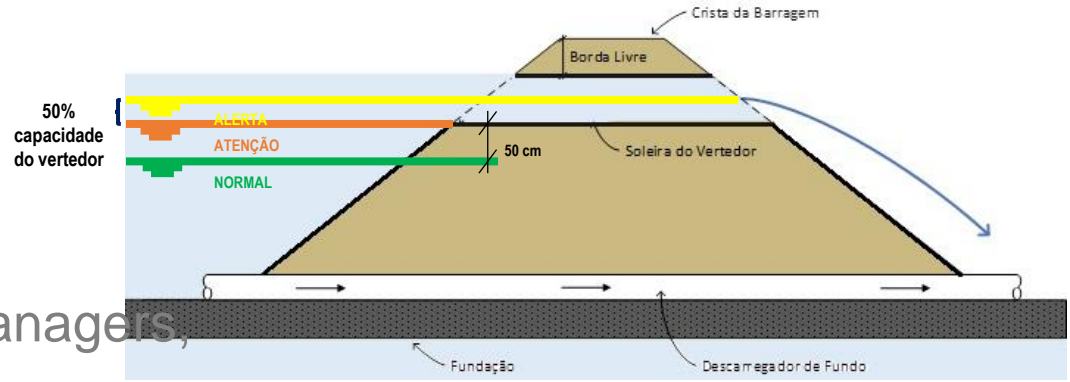




Operational Condition

Alert

- email operational team, managers, directors and corporate
- increases reading frequency
- open depth discharge
- increases reading frequency
- check weather forecast

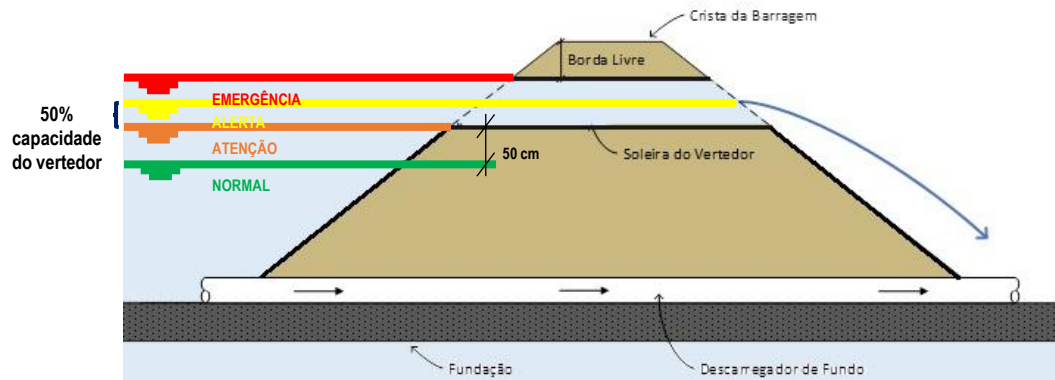




Operational Condition

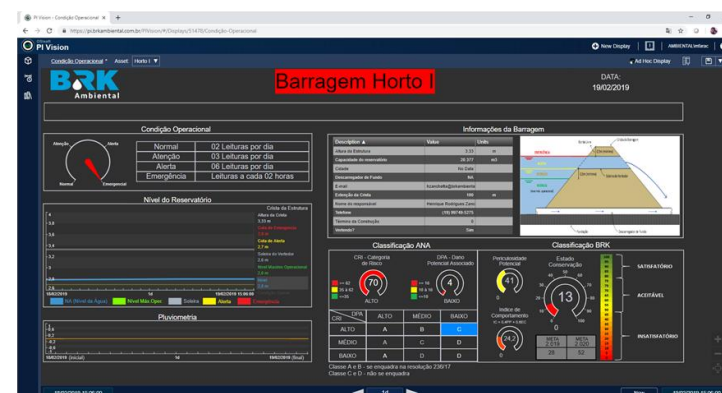
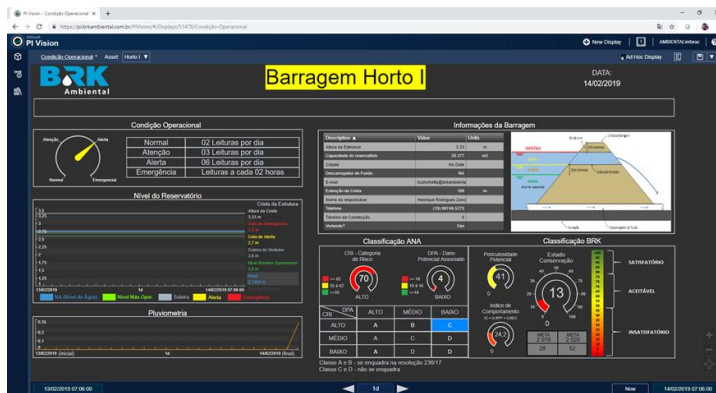
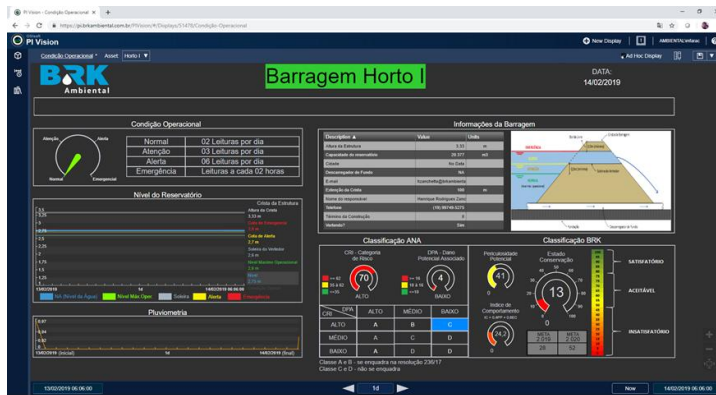
Emergency

- email operational team, managers, directors and corporate
- increases reading frequency
- activates crisis committee:
Warns the population lowers the level of the dam isolates the risk area





Operational Condition



DEMO

Condição Operacional Geral - Barragens

Saneatins

Campeira



Coco



Córrego Urubuzinho



Pernada



Córrego São Borges



ETA003



São João



Água Franca



Água Fria



Bananal



Palmeiropolis



ETA006



Garrafinha



Buritiz



Santo Antônio



Piaus



Papagaio



ETA007



Xinguara



Dianopolis



Dois Irmãos



Córrego Zuador



Na Serra



Limeira

Ribeirão Pinhal



Ribeirão Jaguari



Cachoeiro de Itapemirim

PCH Ilha da Luz



Mairinque

Carvalho



Fiscal



Santa Gertrudes

Captação ETA



Sumaré

Horto I



Horto II



Marcelo





BEFORE

X

AFTER

Scattered information

**DECISION-
MAKING**

Concentration of information in a single environment

Impossible retro-analysis

**OPERACIONAL
PERFORMANCE**

Database generation
Possible retro-analysis

A lot of data manipulation

CONFIABILITY

Greater operational confiability

Greater effort to consolidate data

AGILITY

Immediate access to information

High risk of failure

RISK

Low risk of failure

Excel spreadsheet

INTERFACE

Dashboards, e-mails, graphics,
registration data



“We are knowing the behavior of our structures. The PI system helps us to calibrate the theoric curves of behavior ”

Wagner Ferreira

BRK Ambiental

Dams Safety and Hydraulic Structure



CHALLENGE

- Distribution geography of structures
- Long time to consolidate and make information available
- Inconsistency of data
- Decision making considering small database information
- 80% time formatting data and 20% analyzing

SOLUTION

- Through the PI Manual Logger the structures data are inputted periodically in a manual way, building a historical database.
- In PI Vision it is possible to monitor the operational condition of the structures.
- The PI Notification sends emails to alert those responsible the deviations of structures behavior.

RESULTS

- Agility of decision making to carry out interventions at risk situation.
- Increased reliability of data
- Decreased 8 times the time spent to collect and analyze the data.
- Greater operational reliability

Speakers



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the **microphone**

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