

The slide cover features a photograph of a deicing truck spraying a large commercial airplane. The truck's long boom extends over the wing, and a thick mist of deicing fluid is being applied to the aircraft's surface. The background is a clear, light blue sky. On the right side, there is a blue vertical banner with the text 'ACRP AIRPORT COOPERATIVE RESEARCH PROGRAM' in white. At the bottom left, the text '© ACRP, 2018. All Rights Reserved.' is visible. At the bottom center, there is a small logo for the 'TRANSPORTATION RESEARCH BOARD'. At the bottom right, there is a speaker icon indicating audio content.

L1: Advanced Deicing Runoff Management

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Say: Welcome to the ACRP Advanced Deicing Runoff Management course. We recommend that you view the previous Deicing Runoff Management course prior to this one for contextual reference and background information.

[Click to proceed to next slide]

Course Overview

L1: Adaptive Management and Planning Framework

- Access regulatory compliance status and needs
- Identify deicers used at your airport
- Quantify contributions to stormwater discharges

L2: How Components of Deicing Runoff Management System are Identified and Selected

L3: Components of Deicing Runoff Management System

- Identifies keys to successful Implementation
- How monitoring ensures objectives are achieved



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Say: This course contains three lessons: **[Click]**

lesson 1 explains the concept of adaptive management and introduces the Planning Framework that this course is built upon. You'll learn how to **[Click]** assess regulatory compliance status and needs, **[Click]** identify deicers used at your airport, and **[Click]** quantify their contributions to stormwater discharges.

[Click] lesson 2 explains how components of an airport's deicing runoff management system are identified and selected.

[Click] lesson 3 describes the components of a Deicing Runoff Management Plan, **[Click]** identifies keys to successful implementation of the plan, and **[Click]** explains how monitoring ensures that objectives are achieved. **[Click]** The materials in these lessons are based on ACRP Report 14 Deicing Planning Guidelines and Practices for Stormwater Management Systems.

Let's get started with Lesson 1. **[Click to proceed to next slide]**

Lesson 1: Objectives

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In this lesson you will learn to:

- Describe Adaptive Management
- Explain the Planning Framework
- Assess regulatory compliance status and needs
- Identify aircraft and pavement deicers used at your airport
- Quantify contributions of deicers to stormwater discharges



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Say: In lesson 1 you will learn to:

[Click] Describe the concept of Adaptive Management

[Click] Explain the Planning Framework

[Click] Assess regulatory compliance status and needs

[Click] Identify aircraft and pavement deicers used at your airport

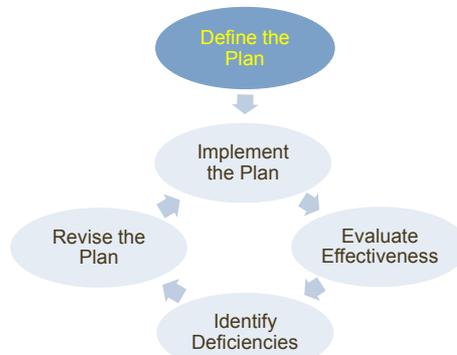
[Click] And Quantify contributions of deicers to stormwater discharges

[Click to proceed to next slide]

Introduction to Adaptive Management

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Say: The concept of Adaptive Management is the foundation for the Deicing Management Planning Framework.

Adaptive management accepts the fact that a plan may not accomplish its objectives in its original form. It provides a structured method for applying experience gained through implementing a plan to improve it over time.

This graphic illustrates the concept. Once the plan has been defined

[Click] it is implemented.

[Click] Implementation is followed by evaluating its effectiveness in accomplishing the objectives.

[Click] This evaluation may identify deficiencies

[Click] which are addressed through to revisions to the plan.

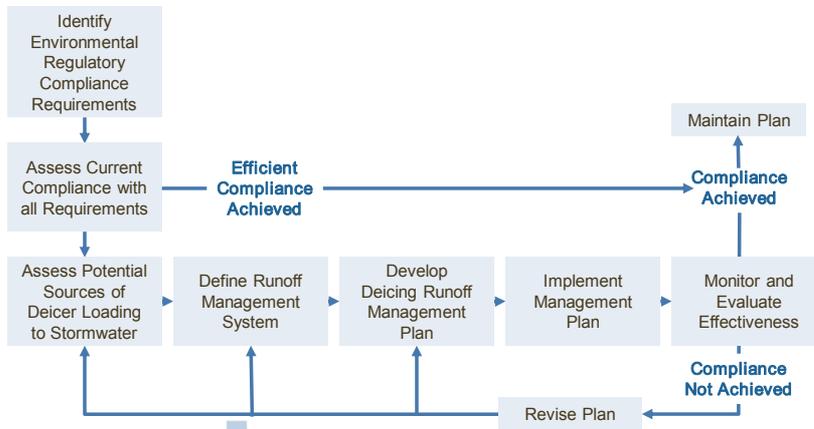
The revised plan is implemented, and the process continues until all of the objectives are achieved.

[Click to proceed to next slide]

Planning Framework

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Say: This planning framework is a roadmap for managing deicing runoff.

It is applicable to current and future requirements and

It is useful in evaluating how well your system is performing in terms of regulatory requirements.

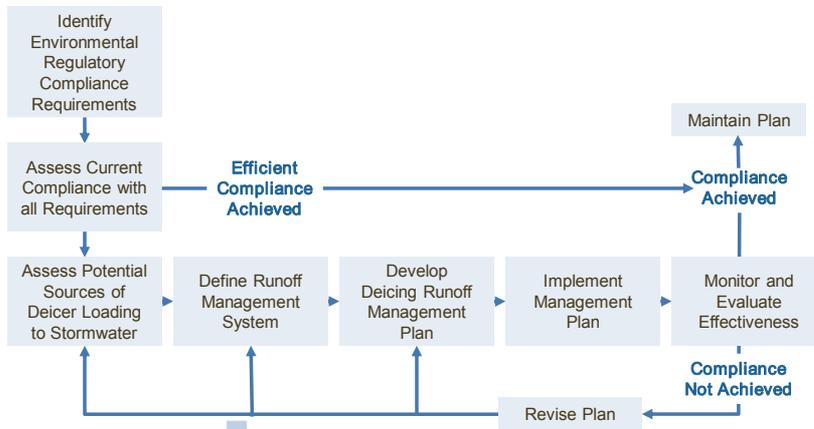
The planning framework is based on proven approaches used in stormwater and watershed management, but adapted to incorporate the specific complexities of the airport and aviation context.

[Click to proceed to next slide]

Planning Framework

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Say: Let's focus on the first critical action steps in the planning process...

[Click] First, Identify environmental regulatory compliance requirements related to deicing. These will be contained in an airport's NPDES stormwater discharge permit.

[Click] Second, assess current compliance with all requirements related to deicing in the permit.

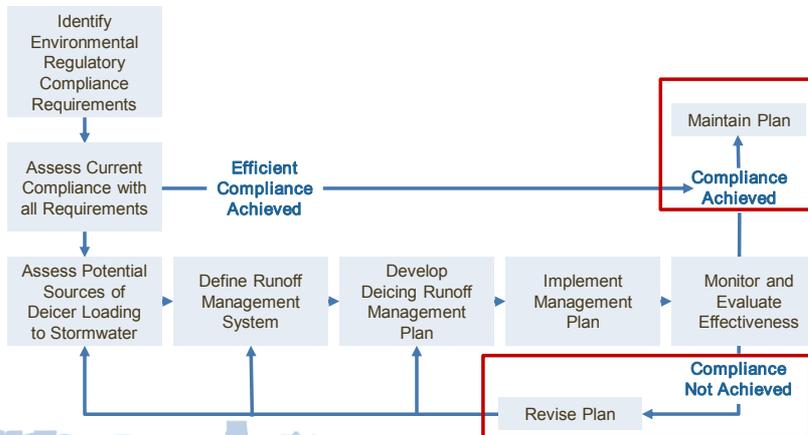
[Click] If compliance is being achieved with the current system, then simply maintain the plan. If compliance is not being achieved, then the main part of the planning framework comes into play.

[Click to proceed to next slide]

Planning Framework

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Say: If regulatory requirements are not being met the airport follows a process whereby:

[Click] Potential sources of deicer loading to stormwater are assessed

[Click] The runoff management system is defined, including sources and transport mechanisms

[Click] A deicing runoff management plan is developed by selecting BMPs in the context of an integrated system.

[Click] The plan is implemented and

[Click] Its effectiveness monitored and evaluated

[Click] If monitoring shows that compliance is achieved –

[Click] stay the course and continue using the defined process.

[Click] If compliance is NOT being achieved,

[Click] each step of the plan is carefully revisited to identify deficiencies, implement appropriate revisions, and monitor to assess the effectiveness.

It is possible, that the changes may not achieve full compliance the first time, or that regulatory requirements change, so the plan may go through several revisions to achieve full compliance. This process of “Adaptive Management” is common to complex stormwater management programs.

[Click to proceed to next slide]

Knowledge Check 1

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True / False

An airport should plan on periodic monitoring, evaluation, and system adjustments after a deicing runoff management program has been implemented.

True

Adaptive Management uses follow up monitoring, evaluation, and revisions to a plan to make sure that all objectives are being achieved.



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Say: It's time for a Knowledge Check.

Is this statement True or False:

An airport should plan on periodic monitoring, evaluation, and system adjustments after a deicing runoff management program has been implemented.

[Click to reveal correct answer]

Correct Answer: True

Adaptive Management uses follow up monitoring, evaluation, and revisions to a plan to make sure that all objectives are being achieved.

[Click to proceed to next slide]



Say: Now let's apply the planning framework to a case study.

[Click for next picture]

For example, let's examine a medium hub airport, with average annual aircraft deicer usage of approximately 150,000 gallons of propylene glycol based product per season.

[Click]

The state regulatory agency has issued an individual stormwater discharge permit to the Airport. because downstream waters exhibit low dissolved oxygen during the deicing season

[Click]

The permit contains limits on biochemical oxygen demand, or BOD in the airport's stormwater discharges.

[Click]

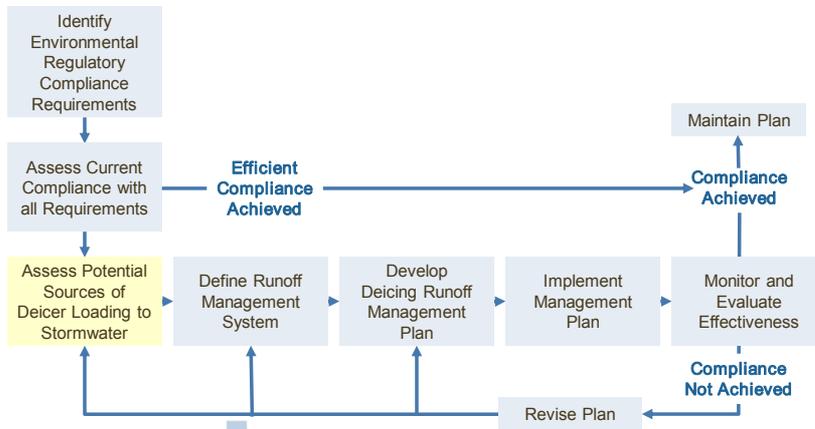
The airport has not been able to comply with these limits on a regular basis.

[Click to proceed to next slide]

Quantify Sources of Deicers in Runoff

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Say: To address the problem, the airport wants to assess potential sources of deicer loading to stormwater, and identify and evaluate sources and transport mechanisms that result in deicers being in stormwater discharges.

Let's walk through the steps to accomplishing this.

[Click to proceed to next slide]

Assessing Potential Sources

- Where is deicing being conducted?
- What types and amounts of deicers are being used in each area?
- Where does the runoff from the deicing areas go?



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Say: We start by asking these questions that will allow us to assess potential sources.

- Where is deicing being conducted?
- What types and amounts of deicers are being used in each area?
- Where does the runoff from the deicing areas go?

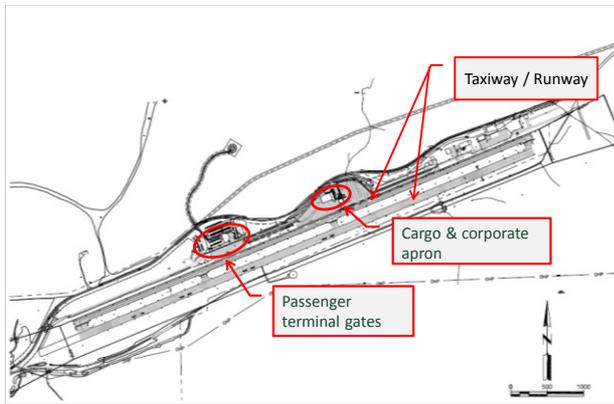
These answers to these questions will help identify where deicers will likely show up in stormwater runoff. The runoff pathways will also be identified so you can start thinking about where runoff can be intercepted.

[Click to proceed to next slide]

Locations Where Deicers are Used

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Say: Begin by identifying where aircraft and airfield pavement deicing operations are conducted at the airport. In our example Aircraft deicing may occur at passenger terminal gates or adjacent apron , or at the cargo and corporate aviation apron. The greatest amount of pavement deicing is conducted on runways and taxiways to keep the airfield operating during winter events, and may also be conducted at apron areas around the airfield.

[Click to proceed to next slide]

Types and Amounts of Deicers Used

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Say: Total deicer usage consists of aircraft deicing AND anti-icing fluids plus pavement deicing materials.

[Click]

Information on the types and amounts of aircraft deicers and anti-icers used are typically obtained from aircraft operators or their deicing service providers.

[Click]

Airfield pavement deicer usage is normally available from the airport's airfield maintenance department. Some airport tenants may also use significant amounts of airfield pavement deicers which should be included in the inventory.

[Click to proceed to next slide]

Calculate Quantities of Deicer Usage

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Drainage Area:	1	2	3	4	5	Total
Type I ADF (gal) (50:50 blend)	100,000	20,000	0	15,000	0	135,000
Type IV AAF (gal)	12,000	2,400	0	1,500	0	15,900
	(Gallons of Type I used) x (Dilution Factor)					
	BOD ₅ = 9.46 X (Gallons Propylene Glycol) Or 5.1 x (Gallons of Ethylene Glycol)					
Potassium Acetate (K-AC) (gal)						
BOD in K-AC (lbs)						36
BOD from all deicers (lbs)	486,155	159,598	31,184	82,548	0	759,484
BOD % All deicers	64%	21%	4%	11%	0%	100%

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Say: Deicer usage data can be analyzed to understand the quantities of deicers being used during the winter season and where they are being used. Note that the three areas where deicing is conducted are in four different drainage areas. In this example inventory, aircraft and pavement deicer usage has been compiled for five different drainage areas at the airport. Please refer to ACRP Report 14 for details on performing these types of calculations.

[Click for table component]

We calculate there are 67,350 gallons of pure glycol in applied Type I Aircraft Deicing Fluid) ADF and Type IV (Anti-icing Fluid) AAF.

[Click for glycol calculation pop-up]

This equation shows how pure glycol used is calculated. The total gallons of Type 1 ADF applied are multiplied by the dilution factor of the applied fluid and the fraction of glycol in undiluted Type I ADF product. This is added to the pure glycol in Type IV AAF, calculated as gallons of applied Type IV AAF multiplied by the fraction of glycol in the Type IV product.

[Click for table component]

Then we can calculate the Biochemical Oxygen Demand, or BOD in the that amount of glycol to get an estimate of the total amount of BOD that comes from aircraft deicers.

[Click for BOD calculation pop-up]

To calculate the pounds of BOD in pure glycol used, the gallons of pure glycol is multiplied by either 9.46 for propylene glycol-based deicers or 5.1 for ethylene glycol-based deicers. The two glycols have different BOD content.

[Click for table component]

The only pavement deicer used is potassium acetate.

Calculate Quantities of Deicer Usage

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Drainage Area:	1	2	3	4	5	Total
Type I ADF (gal) (50:50 blend)	100,000	20,000	0	15,000	0	135,000
Type IV AAF (gal)	12,000	2,400	0	1,500	0	15,900
Glycol in ADF + AAF (gal)	50,000	10,000	0	7,350	0	67,350
BOD in ADF + AAF (lbs)	473,162	94,632	0	69,555	0	637,349
Potassium Acetate (K-AC) (gal)	5,000	25,000	12,000	5,000	0	47,000
BOD in K-AC (lbs)	12,993	64,966	31,184	12,993	0	122,136
BOD from all deicers (lbs)	486,155	159,598	31,184	82,548	0	759,484
BOD % All deicers	64%	21%	4%	11%	0%	100%

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Say [\[Click for table component\]](#)

Just as was done with the aircraft deicers, we can calculate the BOD from the potassium acetate deicer usage. The BOD content of specific pavement deicers can be found in ACRP Report 14.

[\[Click for table component\]](#)

Then we can calculate the total amounts of Biochemical Oxygen Demand or BOD in the amount of glycol used to get an estimate of the total amount of BOD that is generated from aircraft deicer usage.

[\[Click for table component\]](#)

For example there is no aircraft deicing conducted in either drainage areas 3 or 5, but there is pavement deicer usage in drainage area 3. These insights help determine priorities.

[\[Click for table component\]](#)

Which drainage area has the greatest contribution to BOD loading from deicer usage?

[\[Click for table component\]](#)

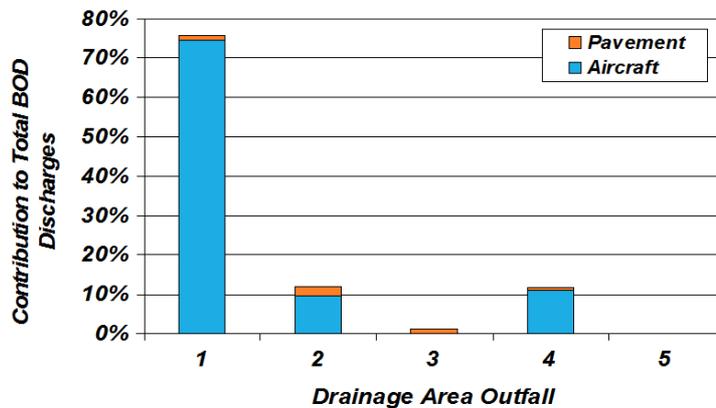
Right, operations in drainage area 1 generate about 2/3 of the total amount of BOD from all deicing at the airport, so this will be our focus in addressing deicing runoff.

[\[Click to proceed to next slide\]](#)

How Does Usage Contribute to Discharges?

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Say: Not all of the deicers that are applied at an airport make it to a stormwater outfall. Some portion of applied deicers is lost or intercepted by various factors between the point of application and the boundary of the airport. Fate and transport calculations are used to estimate the fraction of applied deicers discharged to the environment.

This chart is an example of such an analysis of our hypothetical situation. It shows the relative contributions of deicer usage to BOD in discharges from the five drainage areas. It confirms that Drainage area 1 is contributing the largest amount of BOD from deicers to stormwater discharges. The analysis also shows that the vast majority of deicers in discharges is generated from aircraft deicing. Notice that all of the BOD in Drainage area 3 discharges is produced from pavement deicing. In drainage areas 2 and 4 the majority of BOD in discharges is from aircraft deicers.

[Click to proceed to next slide]

Knowledge Check 1

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Multiple Choice

Which of the following types of deicers are normally included in the inventory of BOD sources?

- A. Type I Aircraft Deicers
- B. Type II and IV Aircraft Anti-icers
- C. Airfield Pavement Deicers
- D. Pavement Salt Used on the Landside
- E. A, B and C

Correct Answer: E. A, B and C - Land deicers are typically salts that do not contain BOD.



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Say: Multiple Choice

Which of the following types of deicers are normally included in the inventory of BOD sources?

- A. Type I Aircraft Deicers
- B. Type II and IV Aircraft Anti-icers
- C. Airfield Pavement Deicers
- D. Pavement Salt Used on the Landside
- E. A, B and C

[Click to reveal correct answer]

Correct Answer: E. A, B and C - Land deicers are typically salts that do not contain BOD.

[Click to proceed to next slide]

Knowledge Check 2

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True / False

Its necessary to apply the entire Planning Framework, regardless of current status of regulatory compliance.

False

The current status of regulatory compliance determines the level of planning analysis that is needed.



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Say: True or False

Its necessary to apply the entire Planning Framework, regardless of current status of regulatory compliance.

[Click to reveal correct answer]

Correct Answer: False

The current status of regulatory compliance determines the level of planning analysis that is needed.

[Click to proceed to next slide]

Lesson 1: Summary

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In this lesson you learned to:

- Describe the concept of Adaptive Management
- Explain the Planning Framework
- Assess regulatory compliance status
- Identify aircraft and pavement deicers used at your airport
- Quantify contributions of deicers to stormwater discharges



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Say: In summary, in lesson 1 you learned to:

[Click] Describe the concept of Adaptive Management

[Click] Explain the Planning Framework

[Click] Assess regulatory compliance status

[Click] Identify aircraft and pavement deicers used at your airport

[Click] And Quantify contributions of deicers to stormwater discharges

You have completed Lesson 1.

Proceed to Lesson 2.